

**LOS ALAMOS NATIONAL LABORATORY**  
**1999 ENVIRONMENTAL STEWARDSHIP ROADMAP**

by

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## EXECUTIVE SUMMARY

The Los Alamos National Laboratory has goals of zero environmental incidents and zero Resource Conservation and Recovery Act violations. The Environmental Stewardship Office, which manages the Laboratory's Pollution Prevention Program, coordinates efforts to eliminate the sources of environmental incidents and violations. Good stewardship eliminates these sources through waste minimization, pollution prevention, and conservation improvements that move the Laboratory toward zero waste produced, zero pollutants released, zero natural resources wasted, and zero natural resources damaged. The fundamental assumptions for Environmental Stewardship and Pollution Prevention are that they not only protect the environment, but also pay for themselves in reduced costs and by creating a safer working environment. Furthermore, they minimize both waste- and pollution-related work tasks, enabling staff to devote more time to mission activities. Practicing good environmental stewardship and reducing the sources of environmental incidents is the responsibility of every person working on the site.

This document summarizes the Laboratory's roadmap for Environmental Stewardship. It describes current operations, improvements that will eliminate the sources of environmental incidents, and the endstate that is the Laboratory's goal. This 1999 version of the roadmap is an amendment to the Laboratory's *1997 Site Pollution Plan*, and it is certified, along with that Plan, to satisfy the requirements of 40 CFR 264.73(b)(9) (RCRA). This version of the roadmap summarizes a systems analysis of Laboratory operations and focuses on waste generation and waste minimization. It also addresses energy and water conservation. Future versions will add analyses and recommendations to reduce the Laboratory's potential pollutant streams and natural resource usage.

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**ACRONYM AND ABBREVIATION LIST**

A/E	Architect/Engineer
ACIS	Automated Chemical Inventory System
AFY	Acre Feet per Year
AHF	Advanced Hydrotest Facility
AK	Acceptable Knowledge
ANSI	American National Standards Institute
APT	Accelerator Production of Tritium
ARIES	Advanced Recovery and Integrated Extraction System
ASCI	Accelerated Strategic Computer Initiative
BUS	Business Operations Division
CCF	Central Computing Facility
CFR	Code of Federal Regulations
CIC	Computing, Information, and Communications [Division]
CMIP	Capability Maintenance & Improvement Project
CMR	Chemical and Metallurgical Research [Facility]
CNMIP	Colorado/New Mexico Intertie Project
County	Los Alamos County
County landfill	landfill the DOE-owned, Los-Alamos-County-operated landfill
CRT	Cathode Ray Tube
CST	Chemical Science and Technology [Division]
CY	Calendar Year
D&D	Decontamination and Decommissioning
DAHRT	Dual Axis Hydrodynamic Test
DOE	Department of Energy
DOE/AL	Department of Energy/Albuquerque Operations Office
DOE/DP	Department of Energy/Defense Programs
DOE/EM	Department of Energy/Environmental Management
DOE/GSA	Department of Energy/General Services Administration
DP	Defense Programs
DSSI	Diversified Scientific Services, Inc.
DU	Depleted Uranium
DVRS	Decontamination and Volume Reduction System
DX	Dynamic Experimentation [Division]
E	Environmental Science & Waste Technology Division
E/ET	Environment/Environmental Technology

**ACRONYM AND ABBREVIATION LIST, Continued**

EMS	Environmental Management System
EPA	Environmental Protection Agency
ER	Environmental Restoration
ES&H	Environment, Safety, and Health [documents, programs, etc.]
ESA	Engineering Sciences and Applications [Division]
ESH	Environment, Safety, and Health [Division]
ESO	Environmental Stewardship Office
FE	Fossil Energy [Division]
FFCO/STP	Federal Facility Compliance Order/Site Treatment Plan
FMU	Facility Management Unit
FWO	Facility & Waste Operations
FWO/SWO	Facility & Waste Operations [Division]/Solid Waste Operations [Group]
FY	Fiscal Year
GET	General Employee Training
GIC Facility	Green Is Clean Facility
GPP	General Plant Project
GSAF	Generator Set-Aside Fee
GWCP	Generator Waste Certification Program
INEEL	Idaho National Energy and Environmental Laboratory
ISM	Integrated Safety Management
JCNNM	Johnson Controls Northern New Mexico
JIT	Just In Time
Laboratory	Los Alamos National Laboratory
landfill	the DOE-owned, Los-Alamos-County-operated landfill
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center Experiment
LAPP	Los Alamos Power Pool
LDCC	Laboratory Data Communications Center
LEDA	Low-Energy Demonstration Accelerator
LINAC	Linear Accelerator
LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level [Radioactive] Waste
LRS	Laramie River Station
MBA	Material Balance Area
MEO	Mediated Electrochemical Oxidation
MLLW	Mixed Low-Level Waste

**ACRONYM AND ABBREVIATION LIST, Continued**

MRF	Material Recycle Facility
MSL	Material Science Laboratory
MT	Metric Ton
MTRU	Mixed Transuranic
MW	Megawatt
NASA	National Aeronautics and Space Administration
NDA	Nondestructive Assay
NHMFL	National High-Magnetic Field Laboratory
NISC	Nonproliferation & International Security Center
NMED	New Mexico Environment Department
NMSWMR	New Mexico Solid Waste Management Regulations
NMT	Nuclear Materials Technology [Division]
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NSCE	Neutron Scattering Center Experiment
ODS	Ozone Depleting Substance
P2	Pollution Prevention
P2/WMin	Pollution Prevention/Waste Minimization
PCB	Polychlorinated Biphenyl
PEP	Project Execution Plan
PMR	Palladium Membrane Reactor
PNM	Public Service Company of New Mexico
PNMGS	Public Service Company of New Mexico Gas Services
PNNL	Pacific Northwest National Laboratory
PPB	Parts per Billion
PPE	Personnel Protective Equipment
PPM	Parts per Million
PVA	Polyvinyl Alcohol
PVC	Polyvinyl Chloride
R&D	Research and Development
Rad	Radioactivity
RANT	Radioassay and Nondestructive Testing
RCA	Radiological Control Area
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal
RLWTF	Radioactive Liquid Waste Treatment Facility

**ACRONYM AND ABBREVIATION LIST, Continued**

ROI	Return on Investment
SCC	Strategic Computing Complex
SNM	Special Nuclear Material
STL	Safeguards Termination Limit
SWB	Standard Waste Box
SWEIS	Site-Wide Environmental Impact Statement
SWO	Solid Waste Operation
SWSC	Sanitary Wastewater System Consolidation
TA	Technical Area
TBD	To Be Determined
TCLP	Toxic Characteristic Leaching Procedure
Tera	$10^{12}$ which equals one-million million
Teraop	(or TeraOp) A unit of computer speed
TFCH	Treated Formerly Characteristic Hazardous [Waste]
Tonne	Metric Ton
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
UC	University of California
VOC	Volatile Organic Carbon
WAC	Waste Acceptance Criteria
WAPA	Western Area Power Administration
WCRRF	Waste Compaction, Reduction, and Repackaging Facility
WIPP	Waste Isolation Pilot Plant
WM	Waste Management
WMC	Waste Management Coordinator
WMin	Waste Minimization
Z	Atomic Number

## **1.0 SCOPE OF ENVIRONMENTAL STEWARDSHIP ACTIVITIES**

### **1.1 Site Description**

Los Alamos National Laboratory (LANL), located within the town of Los Alamos approximately 35 miles northwest of Santa Fe, occupies 43 square miles of land in Northern New Mexico. The Laboratory is divided into 50 technical areas (TAs) with locations and spacing that reflect historical development patterns, topography and functional relationships. Owned by the Department of Energy (DOE), Los Alamos has been managed by the University of California (UC) since 1943.

Los Alamos is located in a temperate mountain climate at an elevation of approximately 7,400 feet. In July, the warmest month of the year, the temperature ranges from an average daily high of 27.2°C (81°F) to an average daily low of 12.8°C (55°F). In January, the coldest month, the temperature ranges from an average daily high of 4.4°C (40°F) to a low of -8.3°C (17°F). The large daily range in temperature results from the relatively dry, clear atmosphere, which allows strong solar heating during the day and rapid radiative cooling at night. The average annual precipitation (rainfall plus the water equivalent of frozen precipitation) is 18.7 inches.

### **1.2 Laboratory Mission**

The central mission at the Laboratory is to enhance the security of nuclear weapons and nuclear materials worldwide. The statutory responsibility is the stewardship and management of the nuclear stockpile. This requires a solid foundation in science and state-of-the-art technology. The Laboratory has approximately 6,800 University of California employees plus approximately 2,800 contractor personnel. Partnering with universities and industry is critical to Laboratory success. Carefully selected civilian research and development programs complement the Laboratory Mission.

There are five aspects to enhancing global nuclear security.

1. Stockpile Stewardship ensures that the United States (U.S.) has safe, secure, and reliable nuclear weapons.
2. Stockpile Management provides capabilities ranging from dismantling to remanufacturing the enduring stockpile.
3. Nuclear Materials Management ensures the availability and safe disposition of plutonium, highly enriched uranium, and tritium.
4. Non-proliferation and counter-proliferation help to deter, detect, and respond to the proliferation of weapons of mass destruction.
5. Environmental Management provides for the remediation and reduction of waste from the nuclear weapons complex.

### 1.3 Environmental Stewardship Mission Statement

The Los Alamos National Laboratory has two major environmental-excellence goals: zero environmental incidents and zero Resource Conservation and Recovery Act (RCRA) violations. The strategy for achieving these goals has two significant elements. First, the Laboratory will comply with all applicable environmental laws, regulations, Department of Energy Orders, and consensus standards. Compliance is managed through the Laboratory's Integrated Safety Management System. The Environment, Safety, and Health (ESH) Division assists Laboratory divisions in planning and maintaining compliant operations. Second, the Laboratory will continue to execute its prevention-based Environmental Stewardship Program that seeks to eliminate the potential for environmental incidents and RCRA violations from Laboratory operations. The Stewardship Program is also a fundamental part of Integrated Safety Management (ISM) at the Laboratory.

The Laboratory Environmental Stewardship mission is to reduce waste and other environmental releases and impacts to zero. The Laboratory's prevention-based program to achieve zero waste is called the Environmental Stewardship Program. The Laboratory chose the "Stewardship" title because pollution prevention (P2) has traditionally implied waste minimization and prevention of environmental releases, while stewardship implies an equal emphasis on engaging all adverse environmental impacts and stressing energy conservation, water conservation, protecting ecosystems, etc. The DOE programs that have these same goals are called Pollution Prevention Programs. Many of the Laboratory's stewardship programs are funded by one of the DOE Pollution Prevention Programs.

### 1.4 Description of the Environmental Stewardship Program

The Stewardship Program is managed by the Environmental Stewardship Office (ESO) of the Environmental Science and Waste Technology Division (E-Division). However, Environmental stewardship is the responsibility of every person working at the Laboratory. The Stewardship Program is based on a systems understanding of Laboratory operations and is summarized through an environmental stewardship roadmap, of which this document is the 1999 version.

The stewardship strategy for attaining zero incidents and zero environmental RCRA violations is to eliminate their source. This is accomplished by continuously improving operations to achieve zero waste, zero pollutants released, zero natural resources wasted, and zero natural resources damaged, as presented below:

- **Zero waste** means continuously improving the planning, design, and operations processes such that the transuranic (TRU) waste, mixed low-level waste (MLLW), low-level (radioactive) waste (LLW), hazardous waste (HAZ), and sanitary waste (SAN) generation are reduced continuously and approach zero. In cases where the Laboratory's programmatic workload increases (and causes increased waste generation), the Laboratory will continue to reduce waste from the increased levels.
- **Zero pollutants** released means improving operations such that only benign substances are released to the environment through gas emissions, effluent releases, or solids dispersal. It also means improving operations continuously such that the

potential for releasing pollutants is continuously reduced. Ozone-depleting chemicals and greenhouse gases are examples of non-benign substances.

- **Zero natural resources wasted** means achieving best-practice operation such that a minimum of electricity, natural gas, and water is consumed. It also means (1) optimizing program and support activities so that a minimum amount of equipment and materials is procured, and (2) ensuring that equipment and materials with a maximum of recycled and bio-based content are preferentially procured. It further means that the Laboratory eliminates procurement of products where their manufacture causes significant environmental damage.
- **Zero natural resources damaged** means respecting the local ecosystem by not interfering with its natural processes. In some cases, controlled burns for example, it may be necessary to manage natural processes; however, in most cases, the ecosystem should be left to manage itself.

The stewardship path to zero includes sensible intermediate steps such as effective recycling, reuse, and waste processing where those steps significantly reduce the Laboratory's environmental footprint. The Stewardship path to zero naturally includes the principle of sustainability and the Code of Environmental Management Principles. The Stewardship path is the Laboratory's approach to going beyond compliance to invest in environmental excellence where ever that investment cost-effectively eliminates the source of environmental incidents. The Laboratory's science and technology base is critically important to developing new, more environmentally-protective products and processes.

## 1.5 Methodology

The environmental stewardship goals are being accomplished by two complementary actions. First, individuals across the Laboratory are evaluating their operations and making process improvements that reduce the possibility of impacting the environment. A significant fraction of the Laboratory's recent waste minimization success is the result of many small improvements instituted by individuals doing the right thing. Second, the stewardship goals are being accomplished through an organized, Lab-Wide Environmental Stewardship Program. This program implements site-wide opportunities for reducing them, organizes metrics for environmental aspects and impacts and analyzes Laboratory operations as a system, identifies the most cost effective opportunities, and implements them. Both the actions of individuals and the Lab-wide program are necessary to achieve the stewardship goals.

The stewardship zero goals need not be achieved all at once or in a particular order. They can be accomplished in ways that make sense in the context of Laboratory missions, budgets, and existing plans. Certain implementation principles, stated below, have proven effective for other organizations and have been incorporated into the Laboratory's program.

- Establish a systems framework for measuring and understanding the sites environmental foot print

- Rank positive return-on-investment (ROI) improvements first.
- Rank improvements based on their quantitative reduction of the environmental foot print.
- Rank improvements based on their pollution prevention value according to the pollution prevention hierarchy. This ranks waste minimization solutions on a spectrum: source avoidance, material substitution, internal recycle, lifetime extension, segregation of wastes, external recycle/reuse, volume reduction, waste treatment, and disposal. Source avoidance is the best, disposal is the least-valued solution.

This 1999 roadmap focuses on the most significant Stewardship opportunities. Eliminating these does not take the Laboratory to zero waste - just 80% of the way. As these most significant opportunities are addressed, future versions of the roadmap will address the next most significant opportunities. The roadmap will be revised and expanded annually.

The control and reduction of waste generated by the Laboratory must take place within certain constraints. Pollution prevention and waste minimization activities must not compromise safety or increase worker exposure to radioactive or hazardous materials. The relationship of pollution prevention to safety is explored in detail in this document in Section 3.0, "Pollution Prevention in Integrated Safety Management." Pollution prevention and waste management also should compromise neither productivity nor product quality. Indeed, successful implementation of good pollution prevention practices should increase both productivity and quality, since waste is a manifestation of lost productivity.

## **1.6 Summary of Regulatory Drivers**

The Environmental Stewardship Program and the stewardship goals are not only good practice and good business, they also satisfy several requirements and regulations for Pollution Prevention and waste minimization programs and plans. These requirements and regulations, which govern the operation of the Laboratory are included in Appendices F and G of the DOE-UC contract. These environmental regulations arise from law, agency directives, executive orders and Laboratory policy. The regulatory drivers are summarized in Table 1-1, which follows.

**Table 1-1. Regulatory Drivers for Environmental Action.**

<b>Driver Type</b>	<b>Driver Code</b>	<b>Driver Title</b>
Law	CAA	Clean Air Act
Law	CWA	Clean Water Act
Order	DOE 5400.1	General Environmental Protection Program
Order	DOE 5820.2A	Radioactive Waste Management
Order	DOE 231.1	Environmental Safety and Health Reporting
Order	DOE 5400.5	Radiation Protection of the Public and the Environment
Order	DOE 5480.19	Conduct of Operations Requirements for DOE Facilities
Order	EO 131XX	Greening the Government through Leadership in Environmental Management
Order	EO 1310	Affirmative Procurement
Regulation	29 CFR 1910	Hazardous Waste Operations
Policy	DOE 450.1	Pollution Prevention in Integrated Safety Management
Policy	LANL SWEIS	Los Alamos National Laboratory Site Wide Environmental Impact Statement
Policy	LANL ISMPDD	Integrated Safety Management Program Description Document
Policy	LANL AM 703	Health, Safety and Environment
Guidance	DOE	Pollution Prevention Planning Guidance
Guidance	DOE	Environmental and Energy Efficiency Leadership Goals for FY 2000 and Beyond

The Laboratory reports the status of its pollution prevention and waste management activities and the progress toward established environmental goals to a number of regulatory agencies. The periodic reports required from the Laboratory are listed in Table 1-2, below.

**Table 1-2. Required Reports.**

<b>Report</b>	<b>Frequency</b>
DOE Site Pollution Prevention Plan	Triennially
DOE Affirmative Procurement Report	Annually
DOE Annual Waste Generation Report	Annually
Certified RCRA Waste Minimization Plan	Annually
Appendix F Performance Measure Self Assessments	Quarterly
Government Performance Results Act	Quarterly
DOE Pollution Prevention Program Report	Quarterly

## 1.7 Relevant Documents and Links

Documents relevant to Environmental Stewardship at Los Alamos include the following:

1. *Los Alamos National Laboratory; 1998, Environmental Stewardship Roadmap*; LA-UR-5947; available at <http://emeso.lanl.gov/>.
2. *Site Pollution Prevention Plan for Los Alamos National Laboratory*; LA-UR-97-1726; available at <http://emeso.lanl.gov/>.
3. *Los Alamos Strategic Overview 1996 - 2015*, available at: <http://lib-www.lanl.gov/la-pubs>
4. *Tactical Plan*, available at: <http://lib-www.lanl.gov/la-pubs>
5. *Institutional Plan 1999 - 2004*, available at: <http://lib-www.lanl.gov/la-pubs>
6. UC Performance Measure Quarterly Reports; available at <http://emeso.lanl.gov/>.
7. *The Site Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory*; DOE/EIS - 0238, Jan. 1999.
8. *Los Alamos National Laboratory Options Study Report on Action Plan for Upgrading Electrical Power System Reliability and Import Capability*, Draft July 1999. LA-UR-99-3788

Other documents of interest may be found on the ESO homepage <http://emeso.lanl.gov/> or the ESH Division homepage <http://drambuie.lanl.gov:80/> .

Other Laboratory web sites relevant to Environmental Stewardship include the following.

- Affirmative Procurement: <http://emeso.lanl.gov/projects/affirmproc/default.htm>
- Recycling: <http://emeso.lanl.gov/recycling.htm>
- Equipment available for reuse: <http://datawarehouse.lanl.gov>

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## **2.0 ASSUMPTIONS USED IN ENVIRONMENTAL STEWARDSHIP PLANNING**

### **2.1 Operational Assumptions**

In compliance with the DOE Pollution Prevention Plan Guidance, the Environmental Stewardship Program defines the following assumptions for the Los Alamos site.

#### **2.1.1 Laboratory operations**

- The Laboratory will be the primary DOE facility for plutonium research and development and for plutonium processing.
- The Laboratory will execute the following major activities:
  - Research and development;
  - Stockpile stewardship and management, including remanufacturing of weapons components, and stockpile surveillance;
  - Stabilization of weapons production residues in response to Defense Nuclear Facility Safety Board Recommendation 94-1 (DNFSB 94-1);
  - Workoff of legacy wastes;
  - Environmental restoration of historically contaminated areas;
  - Decontamination and decommissioning of obsolete facilities; and
  - Disposal of legacy wastes.
- An increasing fraction of Laboratory waste producing activities will be subcontracted.

#### **2.1.2 Waste generation**

1. Growth of Laboratory operations will continue and will tend to increase waste generation and resource consumption.
2. DOE and UC goals and performance measures will require reductions in waste generation and resource consumption.
3. Funding will be adequate to meet the goals and performance measures.

#### **2.1.3 Pollution Prevention**

- A strong corporate pollution prevention effort will remain a Laboratory and DOE priority.
- The DOE will increase its emphasis on site-specific pollution prevention performance measures.
- The Generator Set-Aside Fee Program (GSAF) will continue.
- Adequate funding will be made available for Environmental Stewardship at the Laboratory.

## 2.2 Budget Assumptions

Approval of the budget request for the fiscal year (FY) 2000-2002 Environmental Stewardship Programs (including pollution prevention) is assumed. Environmental Stewardship funding will be adequate to meet the institutions goals and to meet the pollution prevention and waste minimization performance measures.

## 2.3 Organizational Descriptions and Commitments

The Laboratory Director has delegated responsibility for leading Pollution Prevention and Environmental Stewardship efforts for the Laboratory to the Director of the Environmental Science and Waste Technology Division (E-Division). E-Division has established an Environmental Stewardship Office (ESO) to lead the Laboratory's pollution prevention effort. ESO disseminates data on the generation of waste and pollution, establishes incentives for pollution prevention, and brokers pollution prevention investment projects. ESO also reports Laboratory pollution prevention performance and plans to DOE. Each major waste- or pollution-generating division is responsible for organizing its own pollution prevention plan, process, and implementation.

LANL has developed, and uses as a guiding blueprint, a strategic plan for the next five years. The current LANL strategic plan sets out major programmatic objectives and strategies. It also identifies environmental objectives related to most LANL major goals. In addition, a major objective of demonstrating operational excellence in all activities specifically calls out the following strategies.

- Achieve measurable improvements in safety and environmental stewardship through full implementation of the ISM Program throughout the Laboratory; and
- Manage wastes and hazardous legacy materials effectively and accept the challenge of minimizing the generation of hazardous wastes in the future, with a long-term direction toward zero emissions.

Each year LANL also produces an Institutional Plan, a five-year perspective on Laboratory operations. This document identifies strategic requirements for LANL organizational units; summarizes strategic, tactical, and programmatic plans; and helps ensure the integration of LANL activities with DOE priorities.

In partnership with DOE, UC has developed specific overall performance goals for LANL, contained in Appendix F of the operating contract, that emphasize results most important to DOE on an annual basis (see Figure 2-1). Each year LANL renegotiates with UC and DOE this set of specific performance measures in ten administrative and operational functional areas, one of which is environmental restoration and waste management.

LANL's E-Division maintains extensive databases related to environmental information for LANL as an institution and for individual divisions and groups. This data includes measurement of progress toward goals for waste minimization for various waste types.

To ensure an adequate safety envelope and compliance with laws and regulations, facilities at the Laboratory must produce several operations plans, including the following.

- Facility management plans;
- Configuration management plans;
- Facility safety plans;
- Quality assurance plans;
- Emergency action plans;
- Training program descriptions and job analyses; and
- Maintenance implementation plans

All of the above plans represent a process that is integral to ensuring high quality work is accomplished with minimal risk to the worker, his peers, surrounding communities, and the environment.

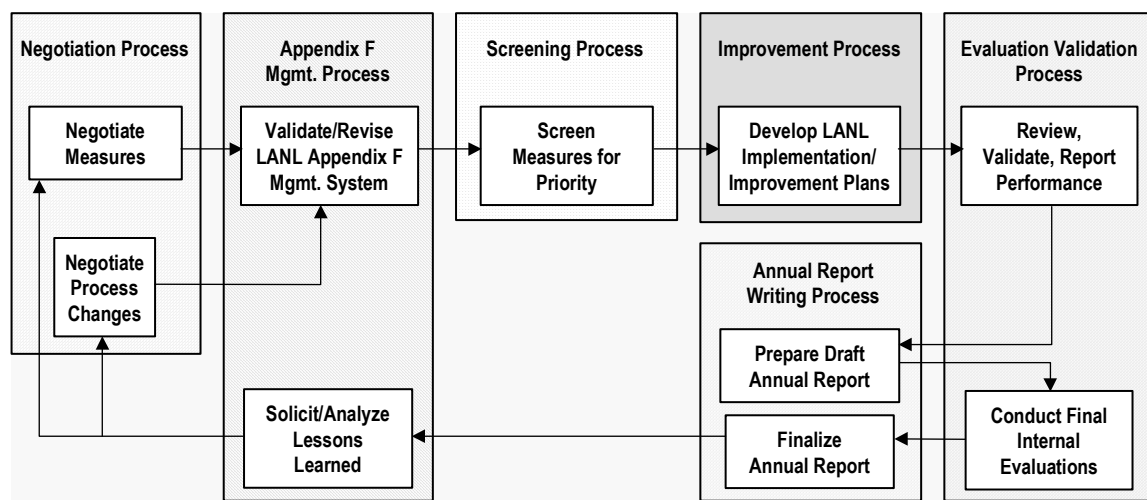


Figure 2-1. Appendix F Process (18-month continuous cycle).

The performance measures found in Appendix F of UC's operating contract provide clear expectations, increase accountability, and improve customer relations by addressing performance issues that concern DOE. Appendix F contains approximately one hundred specific performance measures and associated goals. Over twenty-four of those measures fall within the functional area of environmental restoration and waste minimization. Many more measures directly related to environmental excellence fall within the functional area of environment, safety, and health. The negotiation steps for these measures, the process to set priorities, the improvement steps, and the resulting evaluations all help focus resources on key business processes, improve operational quality, and reduce external oversight by sharing performance results with key customers.

Appendix F requires an annual self-assessment and evaluation by both UC and DOE, but LANL senior leaders also meet quarterly with UC and DOE representatives to discuss current progress against goals and to identify any issues. This regular and frequent interaction helps prevent surprises, mitigate problems, and create a cooperative, rather than an adversarial, atmosphere.

The Appendix F Process is a key performance indicator of our contractual requirements and also a measure of customer satisfaction. Managers monitor progress related to project and performance goals and use that information to develop and/or modify operational plans and to identify areas for improvement. Specific performance measures and progress in meeting them will be detailed as a part of each waste type description later in this document.

### 3.0 Pollution Prevention in Integrated Safety Management

#### 3.1 Summary

Integrated Safety Management (ISM) is the single Environmental, Safety, and Health (ES&H) management system that sets environment, safety, and health policy for all people performing work at Los Alamos National Laboratory. It is also a system for performing work safely and in an environmentally responsible manner.

Although ISM initially focused on worker safety, the Laboratory is systematically broadening ISM to strengthen emphasis on environmental responsibility. Laboratory Director John Browne has included environment in his "Six Zeros" vision statement for the institution:

- ZERO injuries and illnesses on the job;
- ZERO injuries and illnesses off the job;
- ZERO environmental incidents;
- ZERO ethics incidents;
- ZERO people mistreatment incidents; and
- ZERO safeguards and security violations.

In addition, the Laboratory is expanding the scope of the five core ISM functions shown below, in Figure 3-1. The definition of safety has been broadened to include pollution prevention, waste minimization and protection of the environment. Similarly, the definition of hazards now includes hazards to the environment and to institutional physical limits such as water and power supplies. As workers develop hazard controls, a first priority will be prevention of waste or elimination of unnecessary harmful consequences. Work performance will focus on minimizing environmental impact. Performance assurance will include effective pollution prevention/waste minimization measures and a commitment to continuous improvement.

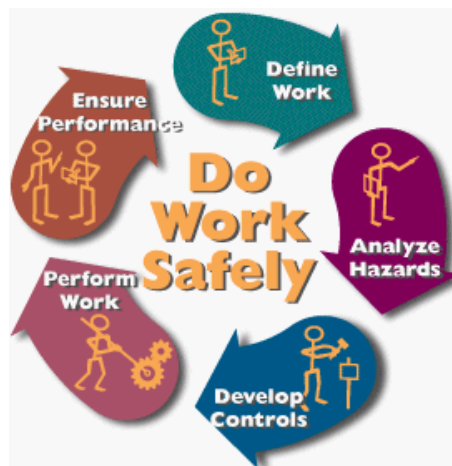


Figure 3-1. The five ISM core functions.

### 3.2 System Description

A key principle for incorporating environmental focus into ISM is that the Laboratory will use processes and systems that already exist without creating new structures unless absolutely necessary. The increased emphasis of ISM on pollution prevention and waste minimization will to encourage more formality of operations and the systematic use of appropriate guidance and tools. The most recent version of the ISM program description document for Los Alamos National Laboratory is *Integrated Safety Management*, (LA-UR-98-2837). The Los Alamos safety web site at [http://www.lanl.gov/safety/pdfs/desc\\_doc.pdf](http://www.lanl.gov/safety/pdfs/desc_doc.pdf) contains detailed information about implementation of ISM at the Laboratory.

#### 3.2.1 Organization of Environment in ISM

Within the ISM System, requirements for worker safety flow into the Laboratory from external regulatory or oversight agencies and are implemented at three levels: institutional, division or facility, and individual activity. Similarly, requirements for environmental protection come to the Laboratory in the form of regulations and guidance and are implemented at all three levels. As shown in Figure 3-2, the Laboratory has begun to identify the integrating elements that link environmental protection across the institution.

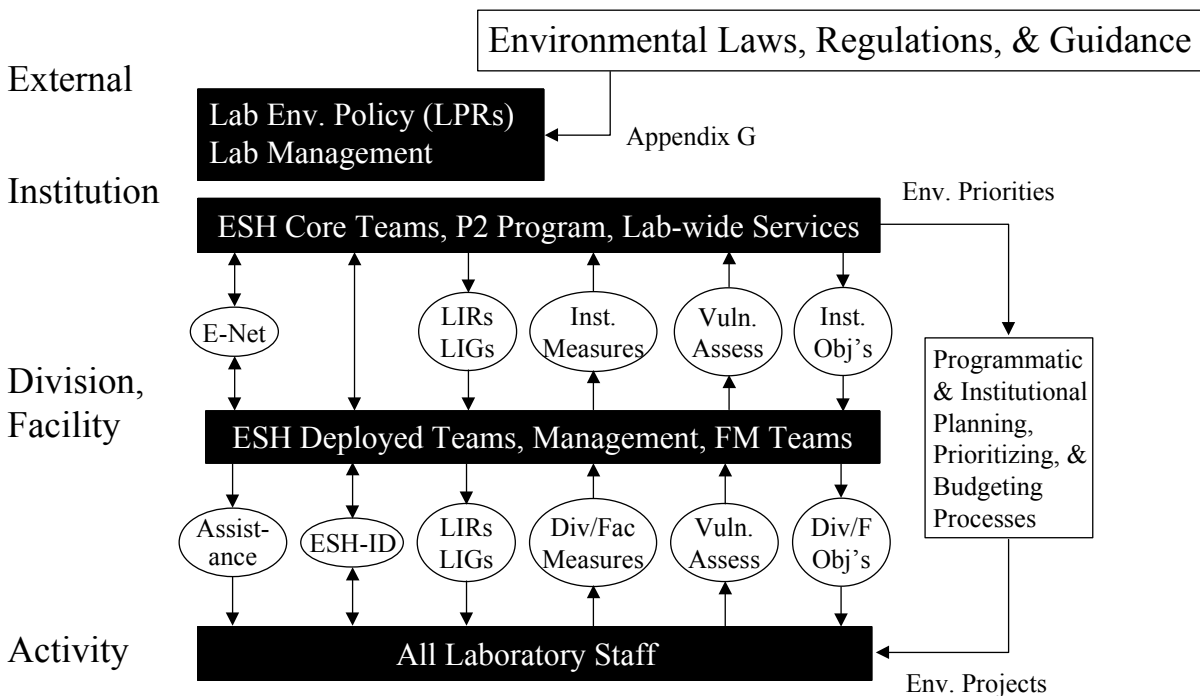


Figure 3-2. Elements that link environmental protection across the institution.

Although many of the elements shown in Figure 3-2, above, are already in place, the Laboratory needs to expand the scope of several of the systems and needs to more fully integrate others. The Laboratory's Environmental Working Group, under the leadership of the Special Assistant for the Environment, from the office of the Deputy Laboratory Director for Operations, has identified several critical actions that collectively can significantly strengthen the Laboratory's environmental focus. Table 3-1 identifies key milestones for the coming year.

The Laboratory expects that within the coming year these milestones, each with a timetable and an assigned champion to oversee completion, will be a part of daily operations or will be well on the way to full implementation.

**Table 3-1. ISM Environmental Protection Milestones**

<b>Milestones</b>
Develop a schedule to implement environmental protection in ISM.
Develop an environmental addendum to the ISM program description document.
Formalize the present environmental objectives funding program.
Establish an environmental protection network.
Revise and fully deploy the Environmental, Safety and Health - Identification Process.
Formalize the process for reviewing environmental requirements for inclusion in Appendix G, LPRs/LIRs/LIGs.
Develop a quality plan for managing environmental protection in ISM.
Establish an annual list of institutional environmental objectives.
Adapt the ESH-19 RCRA assessment process so that it applies to all media.
Establish institutional environmental performance measures.
Formalize an annual institutional vulnerability assessment.
Ensure that division-level ISM strategies include environmental goals that support institutional objectives.

### **3.2.2 Environmental Focus Through the Green Zia Program**

The Environmental Stewardship Office (ESO) has adopted the New Mexico Environment Department's pollution prevention program, the Green Zia Environmental Excellence Program, as a method of promoting continuous learning and improvement. The Laboratory uses the program along with its Integrated Safety Management system, encourage individual

responsibility for pollution prevention and to encourage the use of Green Zia tools to identify opportunities to improve environmental performance. A detailed description of the state Green Zia program can be found at the web site

<http://www.nmenv.state.nm.us/Green%20Zia/Green%20Zia%20summary.html>.

The Los Alamos Green Zia web site, <http://emeso.lanl.gov/projects/greenzia/default.htm>, contains detailed information about implementation of the Laboratory's Green Zia Program. Figure 3-3, below, provides detailed information about efforts at the Laboratory to implement the Green Zia Program.

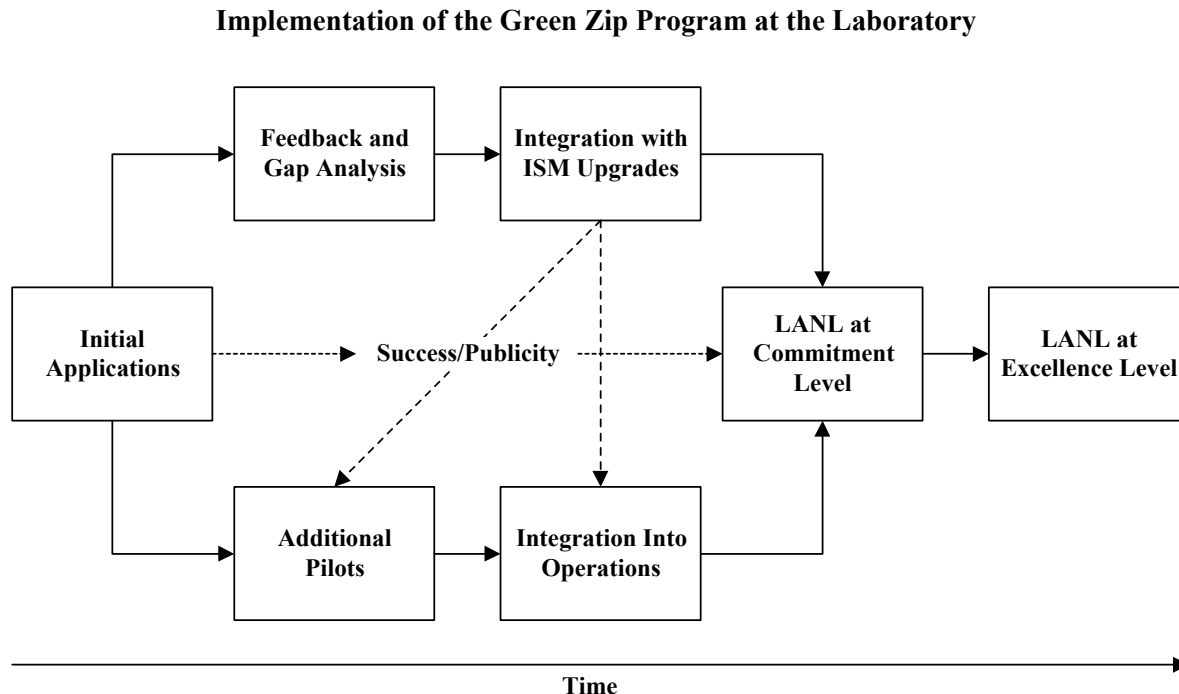


Figure 3-3. The Laboratory's plan to use the Green Zia Program in ISM.

On September 21, 1999, three Los Alamos National Laboratory organizations received 1999 Green Zia Awards from Governor Gary Johnson and New Mexico Environment Department (NMED) Secretary Peter Maggiore. The Transuranic Waste Inspectible Storage Project (TWISP) at TA-54 received an Achievement Award, indicating that evaluators and judges believe the organization has a prevention-based environmental management system in place and is deserving of recognition for middle-level accomplishment. The E Division and the Laboratory's High Explosives Science and Technology Group (DX-2) both received Commitment Awards, indicating management has made a strong commitment to prevention, and the organizations are in the process of creating a framework for a pollution prevention-based environmental management system.

The awards provide suitable recognition for pollution prevention activities, while feedback reports, provided for each applicant by a team of external evaluators, validate those areas judged to show noteworthy environmental performance and also highlight areas for improvement. Analysis of the feedback reports will lead to identification of ways for the Laboratory to create a stronger, more integrated environmental management system.

The Laboratory is continuing to work with the three award-winning areas to ensure continuing improvement and is also developing additional Green Zia pilot projects. Table 3-2 indicates the projects under way for FY00, as well as the focus of each undertaking. One of the FY00 programmatic goals for ESO is to complete a total of eight Green Zia pilots and resulting award applications. Other possible pilot projects will be undertaken by the Laboratory's key subcontractor, Johnson Controls Northern New Mexico.

**Table 3-2. Green Zia Pilot Projects for FY00.**

<b>Title</b>	<b>Project Status</b>	<b>Focus</b>
E-Division Green Zia	Continuing	General pollution prevention
DX-2 Green Zia	Continuing	Wastewater minimization
TA-3 Green Zia	New	Design/construction waste minimization
Otowi Building Green Zia	New	Administrative waste minimization
FWO-SWO Green Zia	Continuing	Secondary waste minimization

As Figure 3-3 on the preceding page shows, the best practices and findings from these pilots will be combined with the findings from implementation of the Laboratory's Integrated Safety Management (ISM) System and will be incorporated into daily operations.

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## 4.0. TRANSURANIC WASTE

### 4.1 Summary

Transuranic (TRU) waste consists of materials containing or contaminated with alpha-emitting radioactive elements with atomic numbers (Zs) greater than that of uranium ( $Z = 92$ ) and with half-lives  $>20$  years. Radionuclides meeting this definition and frequently encountered in LANL operations include  $^{238}\text{Pu}$ ,  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$ ,  $^{241}\text{Am}$ ,  $^{237}\text{Np}$ , and  $^{242}\text{Cf}$ . The contamination must be present at levels  $>100$  nanocuries per gram (nCi/g) at the time of assay (DOE, 1988) for the material to be classified as TRU waste. Mixed transuranic (MTRU) waste is TRU waste determined to contain a hazardous component subject to RCRA, in addition to its radiological component.

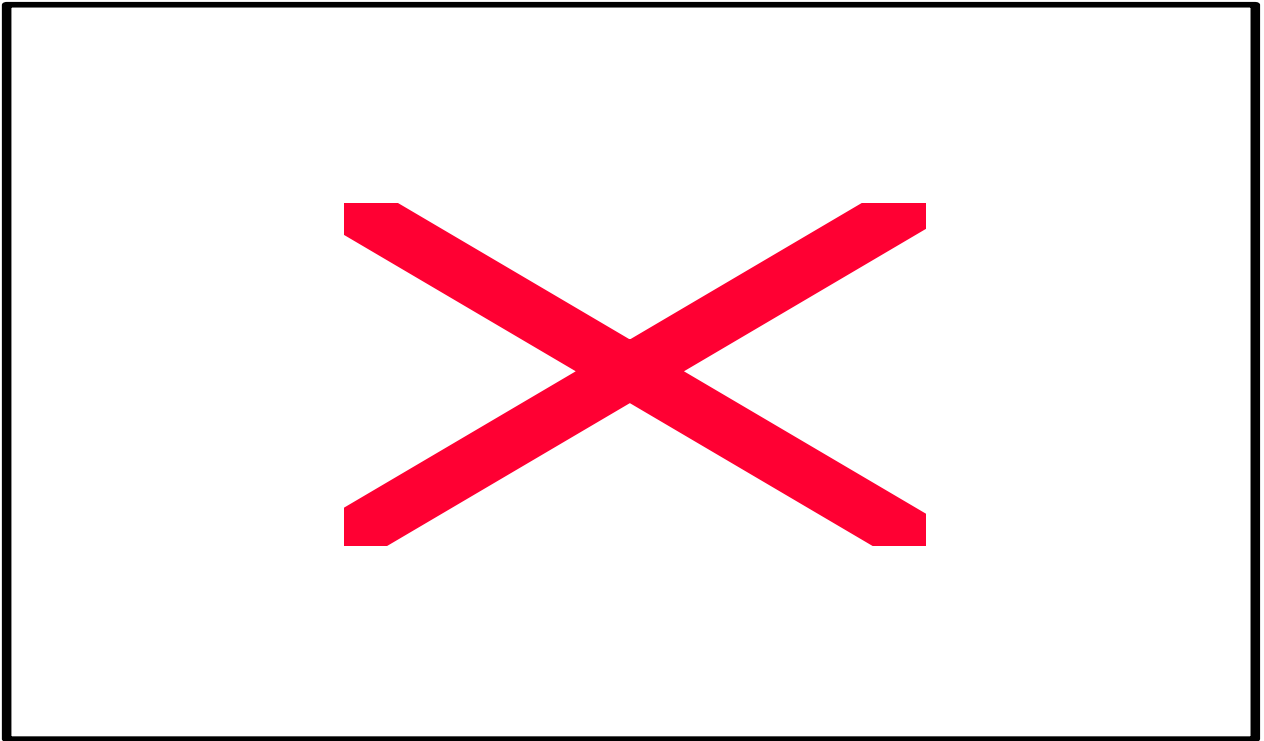
TRU waste at the Laboratory can be classified as either legacy waste or newly generated waste. Legacy waste is that waste generated before September 30, 1998. DOE Environmental Management (DOE/EM) is responsible for disposing of this waste at WIPP and for all associated costs. Newly generated waste is defined as waste generated after September 30, 1998, and DOE/Defense Programs (DP) is responsible for disposing of this waste at the Waste Isolation Pilot Plant (WIPP). This roadmapping effort will focus only on the newly generated wastes. Within this broad category, newly generated wastes are subdivided further into solid and liquid wastes, as well as routine and nonroutine wastes. Solid wastes include cemented residues, combustible materials, noncombustible materials, and nonactinide metals. Liquid wastes comprise effluent solutions associated with the nitric acid and hydrochloric acid plutonium-processing streams. Because of the final pH of these streams, they are also referred to, and reported as, the acid and caustic waste streams, respectively. Routine wastes are those associated with day-to-day operations, room trash, process residues, and spent chemicals and equipment. Nonroutine wastes are those resulting from process upsets, off-normal events (i.e., spills and accidents), and construction or process modification. TRU and MTRU wastes are reported separately because of the differing characterization requirements applied to them. These requirements are detailed in the RCRA and the Federal Facilities Compliance Order/Site Treatment Plan (FFCO/STP).

### 4.2 TRU Waste Minimization Performance

The total volume of transuranic waste generated by the Laboratory is shown in Figure 4-1 and identified as routine, non-routine and environmental remediation waste.

The Environmental Remediation/Decontamination and Decommissioning (D&D) Program has produced TRU waste intermittently, related directly to the area or facility being remediated or decommissioned. In FY97, significant quantities were generated because of the D&D of TA-21, which was the old uranium and plutonium processing site. There has been no TRU waste produced by ER/D&D since that time.

The DOE-wide TRU Pollution Prevention Goal is expected to require an 80% reduction by 2005, from the 1993 calendar year (CY) baseline. For Los Alamos to help achieve the DOE complex-wide goal, the Laboratory will have to reduce routine TRU waste generated to less



than an estimated 80 cubic meters ( $\text{m}^3$ ) by fiscal year (FY) 2005.

Figure 4-1. TRU waste generation by year.

The volume of routine TRU waste has been growing recently, primarily as a result of increased plutonium processing. The recent trend in routine TRU/MTRU waste generation is shown in Figure 4-2 below. The goal shown is the 80% reduction from the CY93 baseline. It is clear that aggressive pollution prevention and waste minimization measures will have to be taken to meet the goal. It should also be noted that the 80% reduction goal is a DOE-wide goal. Several other DOE sites have significantly reduced routine TRU waste. IT is estimated that Los Alamos must reduce its routine TRU waste generation to  $80\text{m}^3$  by 2005 if DOE is to achieve this complex-wide goal.

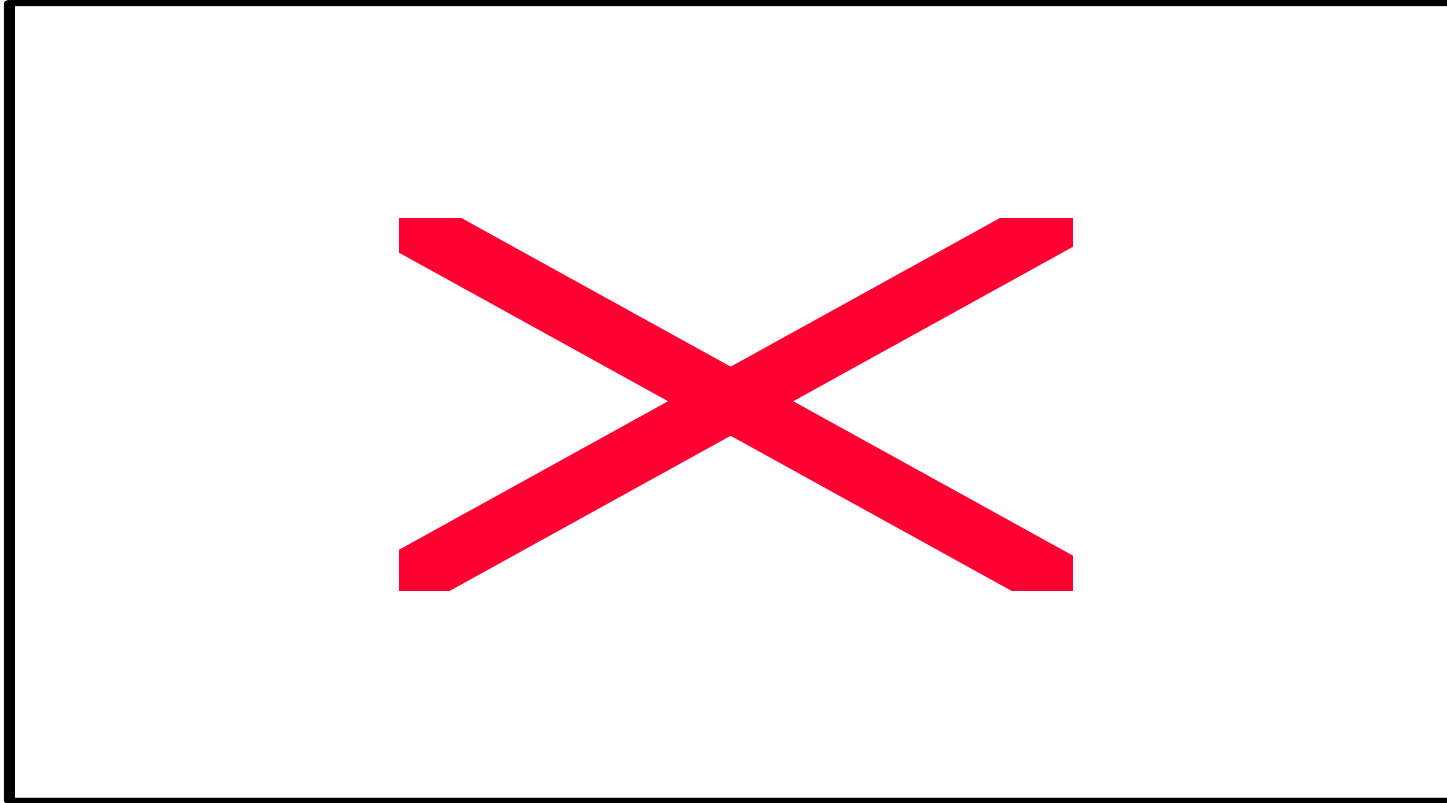


Figure 4-2. Routine waste generation.

The data presented here was obtained from the TRU waste database which is maintained by FWO-Solid Waste Operations at TA-54. Historically, three different sets of TRU data have been kept by DOE, NMT Division, and FWO in the TA-54 TRU database that do not always correlate. The Environmental Stewardship Office reports on the data from FWO which is close to the data kept by DOE. This discrepancy will be addressed to ensure future data consistency and accuracy.

### 4.3 Waste System Description

The majority of the TRU wastes generated at the Laboratory are associated with the Stockpile Stewardship and Management Program, the MilliWatt Heat Source Program, and nuclear materials research and development (R&D). The Nuclear Materials Technology (NMT) Division is the principal waste generator responsible for these programs, which are conducted at the Plutonium Facility (TA-55-PF4) and the Chemical and Metallurgical Research (CMR) Facility (TA-3, Building SM-29). The MilliWatt Heat Source Program is the sole producer of  $^{238}\text{Pu}$ -contaminated TRU waste. TRU waste is also produced from waste characterization and repackaging activities required for waste disposal at WIPP. These characterization activities are performed by the E Division Environmental Science and Waste Technology Group (ET).

Figure 4-3 shows total routine and non-routine TRU and MTRU waste generating organizations by relative volume of waste generated. All the E-ET TRU waste is non-routine.

**FY99 Total TRU Generation at Los  
Alamos National Laboratory (cubic  
meters)**

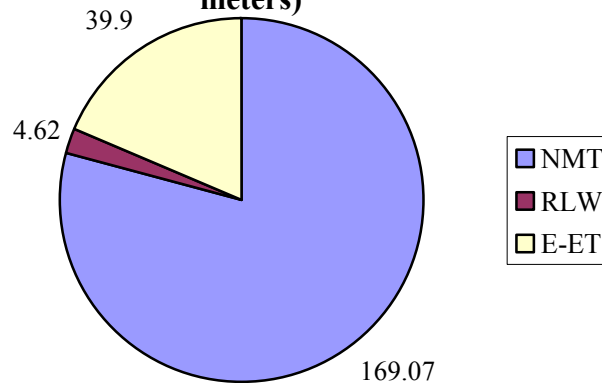


Figure 4-3. TRU and MTRU waste generating organizations.

TRU wastes are generated within radiological control areas (RCAs). These areas are also material balance areas (MBAs) for Security and Safeguards purposes to prevent the potential diversion of special nuclear material (SNM). TRU and MTRU wastes are reported separately because of the different characterization requirements for the wastes. These requirements are detailed in the RCRA and the FFCO/STP - New Mexico Environment Department (NMED), 1995, which stipulates treatment requirements for MTRU wastes. If WIPP receives a “No Mitigation Variance,” these requirements will remain. However, the waste presumably will be shipped to WIPP without treatment, except as needed to meet storage requirements. In the following sections, TRU/MTRU wastes will be discussed as one waste type because the waste minimization strategy for both waste types is the same. At the time this document was prepared, the final MTRU waste volume for 1999 was not available, but in past years the MTRU waste stream has been less than 10% of total TRU waste. MTRU generated in 1999 is expected to follow this trend. The top-level process map for TRU waste is shown in Figure 4-4, below.

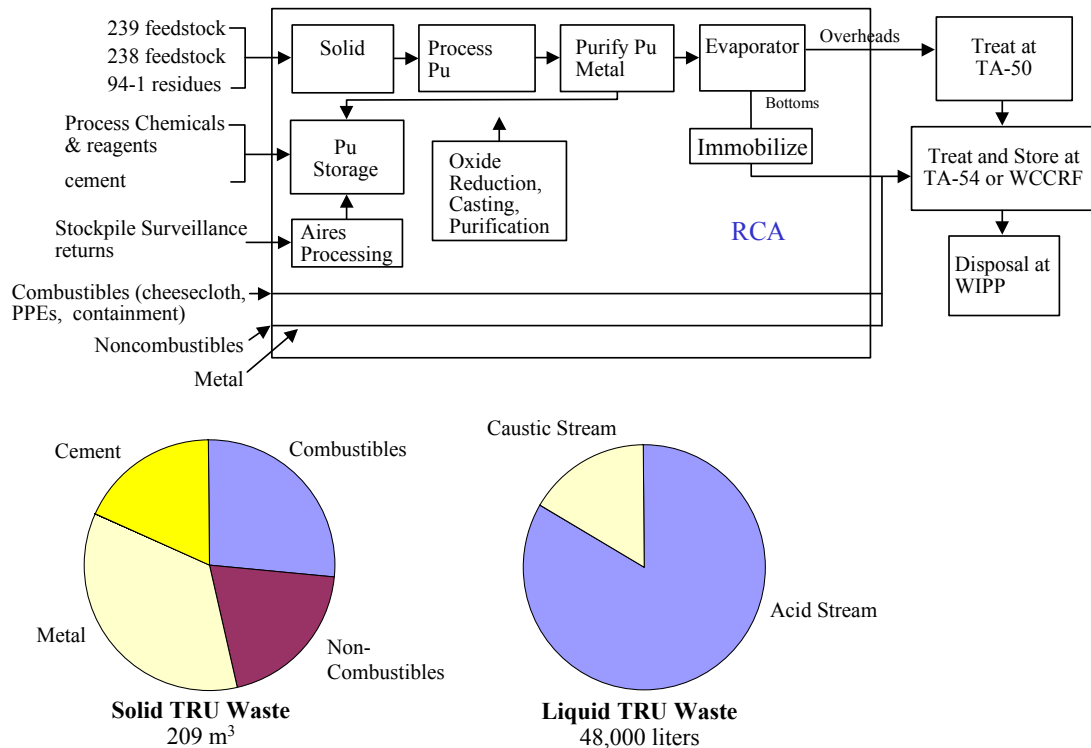


Figure 4-4. Top-level TRU waste process map and waste streams.

TRU materials, process chemicals, equipment, supplies, and some RCRA materials are introduced into the RCAs in support of the programmatic mission. All SNM introduced into Building PF-4, TA-55 are stored in the vault in the PF-4 basement until needed for processing. Because of the hazards inherent in the handling, processing, and manufacturing of plutonium materials, all process activities involving plutonium are conducted in gloveboxes. High levels of plutonium contamination can build up on the inside surfaces of gloveboxes and process equipment as a result of the process or due to leaking process equipment. All materials being removed from the gloveboxes must be multiple-packaged to prevent the spread of contamination outside the glovebox. Currently, all material removed from gloveboxes is considered to be TRU waste. Large quantities of waste, primarily solid combustible materials such as plastic bags, cheesecloth, and protective clothing, are generated as a result of contamination avoidance measures taken to protect workers, the facility, and the environment.

Nonactinide metals are another major TRU waste stream and consist of end-of-life gloveboxes, storage tanks, processing equipment, piping, tools, and transfer containers. Process residues with plutonium contamination less than the Safeguards Termination Limits (STLs) and cemented evaporator bottoms are other solid TRU wastes generated during operations. Process residues exceeding the STL values are returned to the vault for storage and future reprocessing. The pie charts in Figure 4-4 above, display the quantity of each waste type in the total TRU waste volume. In FY99, 214 m<sup>3</sup> of solid TRU waste was

generated. Of this, 27% was combustible material, 22% was noncombustible, 32% was nonactinide metals, and ~18% was cemented process sludge and residues.

TRU solid wastes are accumulated, initially assayed, and characterized at the generation site. TRU solid waste is packaged for disposal in metal 55-gallon drums, 4 x 4 x 6 ft standard waste boxes (SWBs), and oversized containers. Security and Safeguards assay measurements are conducted on the containers for accountability before they are removed from PF-4. The 55-gallon drums are stored in an auxiliary building at TA-55. The SWBs and oversized containers are staged on an asphalt pad behind PF-4 to await shipment to the waste characterization areas at TA-54 or TA-50. Detailed (WIPP) characterization of TRU wastes occurs at TA-54 Building 34, the Radioassay And Nondestructive Testing (RANT) facility; and at

TA-50 Building 69, the Waste Compaction, Reduction, and Repackaging Facility (WCRRF). Samples from drums are sent to the CMR building for characterization in some cases. TRU waste is stored at TA-54, Area G, until it is shipped to WIPP for final disposal. Certification of the waste for transport and disposal at WIPP is the responsibility of the Environmental Science and Waste Technology Group of E-Division. Waste shipments to WIPP began in March 1999.

Liquid TRU wastes from the nitric acid (acidic) and hydrochloric acid (caustic) aqueous processes are transferred from TA-55 to the TA-50 RLWTF via separate, doubly encased transfer lines for processing and further removal of plutonium by flocculent precipitation. The precipitate is cemented into 55-gallon drums and transported to TA-54 for storage and ultimate disposal at WIPP as TRU solid waste. In FY98, ~48,000 L of liquid TRU waste was processed at the TA-50 RLWTF. Eighty percent of this volume came from the acid waste stream and the remaining 20% from the caustic waste stream.

Costs for handling, storage, and disposal of TRU waste have been estimated at approximately \$58,000/m<sup>3</sup> in FY99, these costs are expected to rise in the future because of increased costs of characterization, storage, and disposal.

#### 4.4 Issues

**Issue 1: Waste without a Disposal Pathway.** Recent DOE/DP guidance prohibits (without approval) the continued routine generation of all waste that does not have a disposal pathway. The DOE/Albuquerque Operations Office (AL) has established a procedure for obtaining approval to produce a waste that does not otherwise have a disposition pathway. The Land Disposal Act governing the types and characteristics of TRU waste destined for disposal at WIPP prohibits the disposal of non-DP TRU waste. Plutonium-238-contaminated wastes generated in association with the National Aeronautics and Space Administration (NASA) Heat Source Program are non-DP wastes and thus cannot be disposed of at WIPP under current regulatory restriction. Consequently, all <sup>238</sup>Pu wastes must be stored on site awaiting a disposal option.

**Issue 2: Thermal Wattage Limit for WIPP Transportation.** Current Nuclear Regulatory Commission (NRC) regulations concerning the transportation of TRU wastes to WIPP limit the <sup>239</sup>Pu equivalent loading to 0.2 g per drum to ensure that the hydrogen generated in the headspace during transport does not become explosive. The assumptions used to derive these

headspace values are conservative and pose significant challenges for TRU packaging. Although efforts are underway to adopt revised values, TRU wastes from several of the waste streams will require significant dilution to meet the current thermal wattage limits. For some  $^{238}\text{Pu}$  wastes, this dilution can result in a tenfold increase in waste volumes. Cemented wastes, from the immobilization of process sludge, may require a threefold increase in waste volumes to meet the wattage limits. WIPP is preparing an amendment to the existing values used in the headspace generation calculations, which could relax the thermal limits by a factor of two to three.

**Issue 3: Centralized Decontamination and Volume-Reduction Capability.**

Decontamination of TRU-contaminated objects for disposal as LLW is performed in place using electrolytic decontamination, chemical washing, or some other technique. Frequently these large metallic items, including gloveboxes, are recontaminated before they can be removed from the facility because of ventilation upsets. A centralized decontamination and volume-reduction facility is needed to allow these large items to be removed from the facility, relocated, decontaminated, and volume-reduced to minimize the cost of disposal. For many TRU waste gloveboxes, this will require removing lead shielding so that the gloveboxes can be disposed of as LLW.

Because of the safety concerns posed when performing operations with high levels of TRU waste contamination, the design and construction of this type of facility is both time consuming and expensive. The Decontamination and Volume Reduction System (DVRS) being designed and built at TA-54 will meet this need for gloveboxes. However, the present DVRS design does not allow for decontamination and volume reduction of storage tanks, long process piping, and process equipment. In addition, an alternate facility for glovebox decontamination and volume reduction is needed until the DVRS is fully operational. Therefore, to ensure that such a capability to treat TRU waste, oversized, metallic objects effectively is available to meet the needs of the Laboratory, a plan must be developed and implemented as soon as possible.

**Issue 4: NDA Differentiation between TRU Waste and LLW.** Existing nondestructive assay (NDA) techniques are difficult and frequently fail to differentiate TRU waste from LLW when the levels of activity fall between 10 and 100 nCi/g. This limitation is particularly pronounced when the background radiation levels are elevated, as they are at some locations in the TA-55, PF-4 facility. Consequently, significant quantities of LLW are improperly classified as TRU waste and must be handled at a much higher cost. If improperly classified waste is discovered when the waste is prepared for disposal at WIPP, it can be reclassified. Reclassification can be a critical issue for MTRU waste which may have no disposal pathway, if such MTRU waste were reclassified as MLLW.

**Issue 5: WIPP Characterization Requirements.** Characterization requirements for TRU wastes that are destined for burial at WIPP are intensive, time consuming, and expensive. LANL has developed a detailed sampling plan to demonstrate that the contents of the TRU waste drums scheduled for shipment are characterized adequately and do not contain any RCRA constituents. RCRA contaminants currently are prohibited from shipment until the State of New Mexico issues the RCRA Part B permit authorizing disposal of RCRA wastes, and thus, MTRU wastes at WIPP.

**Issue 6: Decontamination of MTRU Waste to MLLW.** Significant manpower and funding resources are being expended to minimize the quantity of TRU and MTRU waste generated. Decontamination of gloveboxes for reclassification from TRU waste to LLW is included in the focus of this effort. However, many gloveboxes and other process equipment contain, or have been contaminated with, RCRA-regulated constituents such as lead. Currently, there is a disincentive for decontaminating MTRU wastes to LLW levels without eliminating the RCRA constituents because there is frequently no disposal pathway for MLLW. Decontamination strategies must account for this potential to ensure that the final waste has a disposal pathway.

**Issue 7: Construction.** The Laboratory will spend over \$1.2 billion over the next 10 years upgrading facilities and process equipment to meet the changing mission that is focused on the Stockpile Stewardship and Management Program. Much of the activity will be in RCAs and will involve the replacement of TRU-contaminated systems and equipment. Large quantities of TRU wastes will be generated unless pollution prevention and waste minimization are included and fully integrated into the overall construction process.

## 4.5 TRU Waste Streams

The TRU waste stream is the result of Laboratory missions focused on the Stockpile Stewardship and Management Program, MilliWatt Heat Source Program, and nuclear materials R&D. NMT Division is the predominant generator of TRU wastes. In their efforts to reduce plutonium-contaminated wastes generation and to minimize the total quantity of plutonium discarded annually, NMT has committed to a path forward that is described in detail in the TA-55 Waste Minimization Program Plan (Foxy, 1996). This plan provides in-depth discussion of the projects and goals of the Division. Also, NMT recently developed and issued the NMT Waste Management Program Plan that presents the philosophy and expectations for environmentally conscious plutonium processing. The goals of this plan are to reduce liquid waste by 90% and to essentially eliminate the combustible waste stream by 2003.

### A. Combustible Wastes

Combustible wastes comprise ~27% of the solid TRU waste generated at the Laboratory. For the MilliWatt Heat Source Program, combustible solids account for almost 90% of the TRU wastes contaminated with  $^{238}\text{Pu}$ , for which there is currently no disposal pathway. In all instances, combustible waste is comprised largely of plastic bags, plastic reagent bottles, plastic-sheet goods used for contamination barriers, organic chemicals and oils, cheesecloth, gloves, and protective clothing worn by workers. The process map for combustible waste is shown in Figure 4-5 below. When combined, these options are expected to eliminate or significantly reduce this waste stream.

Also as shown in Figure 4-5, NMT Division has taken numerous aggressive actions to minimize the combustible waste stream. These actions are detailed in the TRU Combustibles Matrix Destruction/Treatment Approach. This plan presents NMT's vision for pilot implementation, evaluation testing, and selection of initiatives to address the various combustible waste streams associated with plutonium operations. See Section 4.6 Initiatives, for a detailed discussion of the various treatment initiatives.

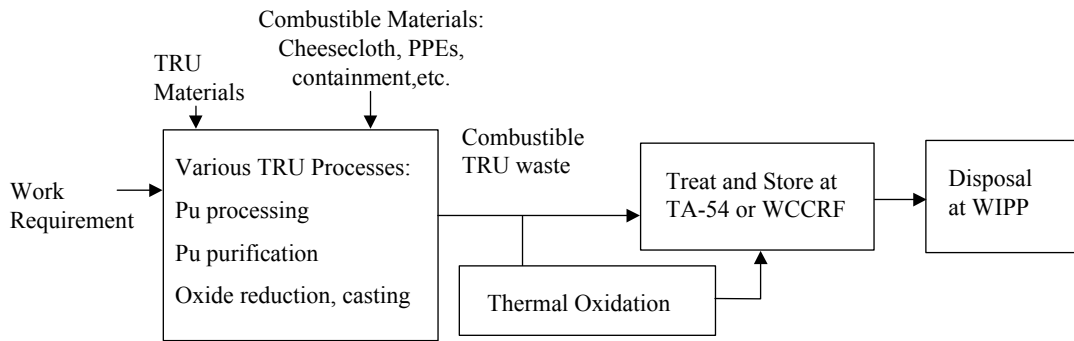


Figure 4-5. Process map for combustible TRU waste.

In addition to this plan, several other programs have been implemented to reduce the quantities and types of combustible waste being generated including the following:

- Extensive training for all PF-4 workers, which focused on the need for ways to prevent or minimize waste as part of the access control program.
- Incorporation of waste minimization practices into routine facility procedures.
- Significant expansion of the NMT-7 Waste Management and Environmental Compliance Group to assist operation personnel with waste management issues, including a Project Leader for Waste Minimization (Waste Min) to lead the efforts on combustible waste treatment technologies selection and downsizing.
- A prohibition on bringing any unnecessary items into PF-4 that may become contaminated and have to be removed as waste.

## B. Noncombustible TRU Waste

Noncombustible TRU wastes are composed of materials that prohibit thermal decomposition treatment because mixed metallic, glass, graphite, or other noncombustible materials exceed 10% of the waste volume. The process map for noncombustible wastes is shown in Figure 4-6.

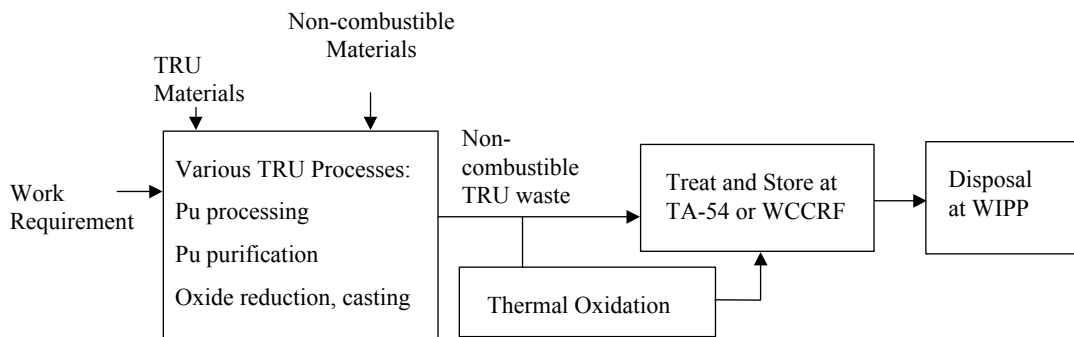


Figure 4-6. Process map for noncombustible TRU waste.

NMT has reduced the volume of noncombustible TRU wastes through improved segregation at the time the waste is generated. As discussed in greater detail later, diversion of glass waste to the vitrification process and introduction of reusable tantalum molds for component casting also will significantly reduce the noncombustible waste volumes.

### C. Nonactinide Metals

Nonactinide metals are any metallic waste constituents that may be contaminated with, but are not fabricated out of, actinide metals. Metallic wastes typically include tools, process equipment, glovebox structures, facility piping, and ventilation ducting. Figure 4-7 presents the process for metallic TRU waste. Significant volumes of metallic waste are generated under the following conditions: (1) when gloveboxes have reached the end of their useful life; (2) when processes within the facility and glovebox are changed; (3) when routine and nonroutine maintenance activities are completed; and (4) as facility construction projects are implemented to meet new programmatic missions.

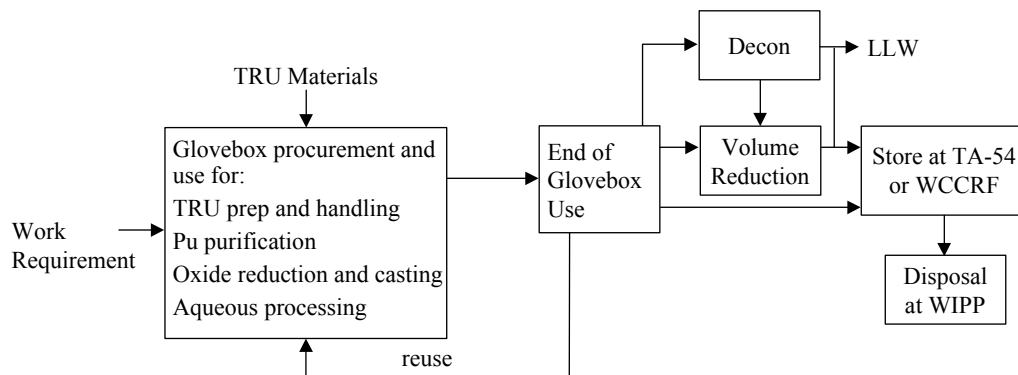


Figure 4-7. Nonactinide metals.

### D. Cemented Wastes

Cemented wastes are those acidic and caustic processing sludges and oxalate precipitation residues that contain levels of plutonium exceeding the STLs but containing less than the values requiring reprocessing. Before being discarded, the residues must be immobilized to minimize their potential attractiveness for diversion. Cementation meets this immobilization requirement. The high concentrations of actinides in this sludge frequently exceed the thermal wattage limit for WIPP disposal and require dilution by as much as a factor of five to meet certification requirements. NMT has been pursuing several alternatives to resolve this issue. The process map for cemented waste is shown below in Figure 4-8.

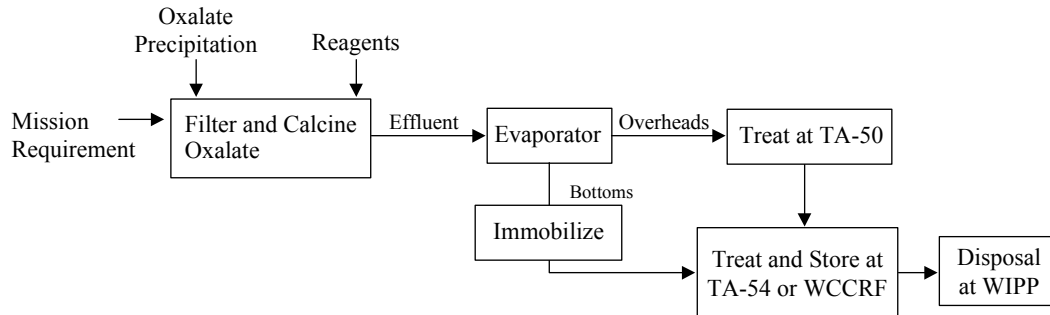


Figure 4-8. Process map for cemented TRU waste.

### E. Caustic Liquid Waste

Caustic liquid waste results from the final hydroxide precipitation step in the aqueous chloride process. Feedstocks for this process are typically anode heels, chloride salt residues, and other materials having a relatively high chloride content. Figure 4-9 below shows the process map for this waste stream. Efforts are underway to upgrade the throughput capabilities of the aqueous chloride process in order to handle the increased quantities of chloride residues that will result from workoff under the 94-1 Residue Stabilization Program. Over the next 3 to 5 years, throughput quantities are expected to double. Caustic process liquids are transferred to TA-50, RLWTF, for final processing via the caustic waste line.

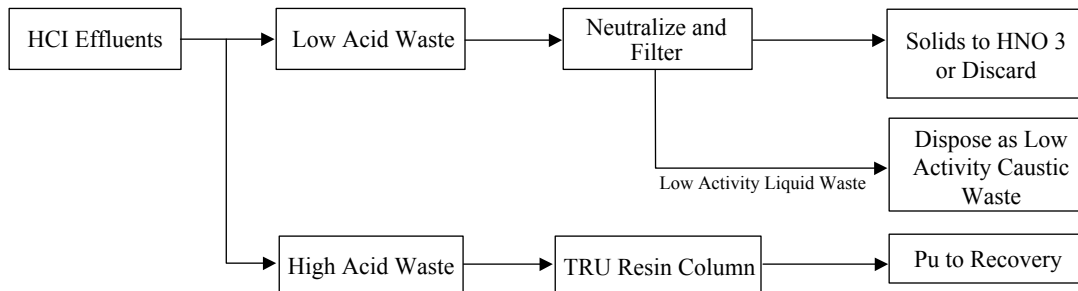


Figure 4-9. Process map for caustic liquid TRU waste.

### F. Acidic Liquid Waste

Acidic liquid waste is derived from processing plutonium feedstock with nitric acid for matrix dissolution. Following oxalate precipitation, the effluent is sent to the evaporator, where the overheads are removed and sent to the acid waste line for further processing. Evaporator bottom sludge is cemented into 55-gallon drums for disposal. Figure 4-10 below shows the process map for the Nitric Acid Recovery Process.

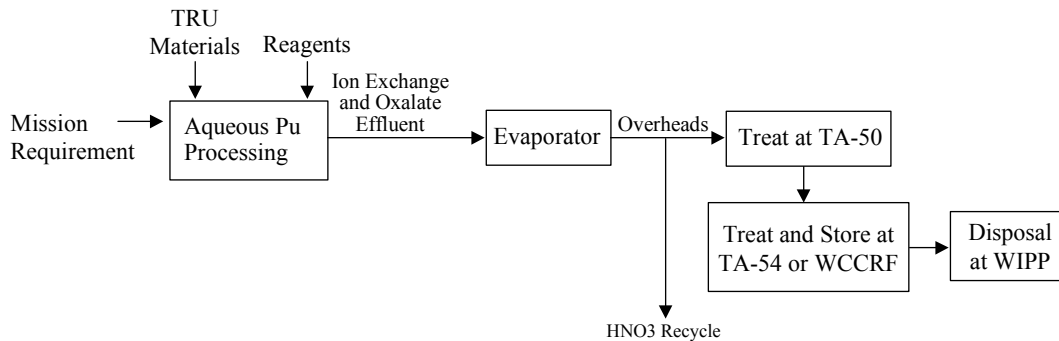


Figure 4-10. Process map for acidic liquid TRU waste.

**4.6 Initiatives** These initiatives are multiple redundant solutions for minimizing each TRU waste stream. Some are being developed or evaluated, others are being implemented.

#### **Initiative T-1: Combustible TRU Waste**

- Pyrolysis and Catalytic Conversion.** This process destroys organic matrices (e.g., cellulose rags, plastics, and gloves) by thermal decomposition. By-products include liquid and vapor phase organic compounds. A 150-g/day throughput unit has been installed in TA-55 and is used to decompose polystyrene and cellulose rags. A large-scale pilot unit able to decompose 500 g/day is being developed for installation. Efforts also are proceeding to develop and test a unit capable of destroying other plastics. Chlorinated plastics are a problem for this process.
- Hydrothermal Destruction.** With hydrogen peroxide as the oxidant, organic wastes are oxidized to carbon dioxide and water at high temperature and pressure. This process is suitable for treating organic liquids and small-particle-sized solids. The products are a slightly acidic solution and precipitated actinide compounds. Currently, an experimental unit is operational in a TA-55 glovebox. A larger pilot-scale system will be designed and tested on a wider variety of combustible waste materials.
- Molten Salt Oxidation.** Combustible organic materials are decomposed by combining them with oxygen in a molten carbonate bath. This process works on organic wastes and pyrolysis ash. The by-products are carbon dioxide, water, and contaminated carbonate salts. This process currently is being pursued by NMT-9 to treat  $^{238}\text{Pu}$ -contaminated combustible materials and has received DOE EM-50 ASTD funding to develop and deploy the technology within a glovebox at TA-55. When combined with aqueous recovery of the plutonium present in the carbonate salts,  $^{238}\text{Pu}$  can be recovered and purified for reuse.

**Note:** NMT Division is in the process of evaluating the preceding three technologies with the intent to select one or two for implementation at TA-55. It has been

estimated that when the selected technology(s) is implemented the combustible TRU waste stream will be reduced by ~90%.

- **Volume Reduction Using Cryogenic Grinding.** This process subjects plastic materials to extremely cold temperatures using liquid nitrogen and then grinds the frozen material in a mechanical grinder. The process reduces the waste volume by ~70%. Cryogenic grinding has been demonstrated, and a large-scale design is needed.
- **Elimination of Polyvinyl Chloride Plastics.** Many of the plastic gloves, bottles, bags, and contamination barriers currently in use within PF-4 are made from polyvinyl chloride (PVC). When PVC is decomposed thermally, one of the by-products is hydrochloric acid, which is quite corrosive and rapidly destroys metallic process equipment, gloveboxes, facility piping, and ventilation ducting. Substitution of an alternative plastic such as polyethylene will eliminate the generation of acids and will significantly prolong process equipment lifetimes. Longer residence time for equipment decreases the TRU-contaminated waste stream.
- **Use of Polyvinyl Alcohol-Based Materials.** Cloth-like fabrics, mop heads, clear sheet goods, and other substitutes for cellulose-based products are now being manufactured and used extensively in the medical industry. The new generation of polyvinyl alcohol (PVA) materials remain soluble in aqueous solutions and can withstand water bath temperatures up to 190°F. If alternate treatment technologies could be employed to dissolve, treat, and recover the plutonium from this material, these products could provide an alternative to the cellulosic products requiring thermal decomposition to treat and destroy.
- **In-Line Waste Assay and Packaging System.** Waste generated in gloveboxes at PF-4 is removed from the glovebox line via the bagout process to be assayed. The plastic-bagged item is placed in a drum that is lined with a heavy PVC bag. The bags of waste items capture air along with the waste item and typically are packaged in an irregular manner in the drum. Multiple void spaces result from this method of packaging. Waste streams from PF-4 gloveboxes could be assayed, sorted, and segregated more effectively and safely if this activity were performed in-line (i.e. inside a glove box). In addition, a significant volume of PVC waste could be avoided and more material packaged into a single drum if the drumout were conducted in-line. It is expected that implementation of this option would decrease the number of drums generated in PF-4 by 50%.
- **Sonitol Dry Cleaning.** Barlett Services, Inc. has recently demonstrated a non-aqueous cleaning process for clothing heavily contaminated with plutonium. This process should be capable of decontaminating many TRU combustible material to LLW.

### **Initiative T-2: Noncombustible Initiatives**

- **Aliquot Mold and Blending.** This project will modify Pu-alloy casting which is currently done as a single batch melt and cast into rods and then into a single

hemisphere of metal. The new process casts a set of smaller alloy aliquots from a single, homogeneous melt. If the entire batch does not meet specifications, individual aliquots can be combined with aliquots from other batches to provide a composite feed to the final casting process that meets specifications. This new process is expected to reduce rejection rates to essentially zero.

- **Laser-Induced Breakdown Spectroscopy.** Plasma ionization of microgram samples of plutonium using a laser produces characteristic photon patterns that can be evaluated to determine the isotopic content and ratios present in the sample. Unwanted contaminants also can be quantitatively and qualitatively measured with an analytical turnaround time of hours rather than months. Eliminating the need for the multigram sample sizes currently required will prevent the need to dispose of the remaining sample or to return it for reprocessing. Adoption of this new analytical technique will virtually eliminate the waste currently associated with sample analysis.
- **Electrorefining Salt Distillation.** This process distills the potassium and sodium nitrate salts used in several pyrochemical processes away from the solid nuclear material oxides. It produces salts that are reusable and that no longer must be discarded as LLW or TRU waste.

### **Initiative T-3: Nonactinide Metal Waste.**

- **Electrolytic Decontamination.** The electrolytic decontamination of gloveboxes and other metallic components can reduce them from TRU waste to LLW or make them more attractive for reuse because of the lower levels of residual contamination. Use of electrolytic decontamination sharply reduces the volume of solid and liquid waste generated compared to other decontamination techniques. Because the technique is more rapid than others, and because the process can be left unattended for periods of time, workers receive a lower radiation dose during the course of decontamination using this technique. This technology is operational in PF-4, TA-55
- **Use of Chemical Decontamination Agents.** Various new chemicals for decontamination of equipment and surfaces are being developed. Some of these include leaching gels and foams that are supposed to be effective for decontaminating nonmetallic surfaces, such as those in many of the CMR gloveboxes. Use of these products, after testing and evaluation to identify the most effective decontamination agent, could reduce the volume of TRU waste generated from CMR significantly.
- **Precious Metal Decontamination.** Approximately 100 kg of plutonium-contaminated precious metals have been identified as a candidate for electrolytic decontamination as part of the 94-1 vault clean out and residue stabilization program. The estimated value of the gold, platinum, and platinum/rhodium alloys is approximately \$1 million. After decontamination, a significant portion of these precious metals could be returned to the DOE Precious Metal Pool for reuse throughout the complex.
- **Use of Strippable Coatings.** The use of strippable coatings could be increased to minimize the need for extensive glovebox decontamination prior to glovebox reuse

or removal. Use of these coatings could decrease the amount of TRU waste generated by increasing the number of gloveboxes decontaminated to LLW levels or free-release criteria.

- **Construction and Operation of the DVRS at TA-54.** The DVRS is currently being designed for installation and deployment at TA-54 to handle oversized metallic legacy waste and newly-generated TRU glovebox wastes.

#### **Initiative T-4: Cement Waste**

- **Vitrification.** Vitrification of radioactive wastes is the high-temperature process of converting solid and semisolid waste streams into monoliths using glass frits as a medium for stabilization. Vitrification of these wastes is a solution to the current problems of hydrogen generation and container corrosion associated with cemented wastes. Because hydrogen generation will no longer be of concern in the vitrified waste form, the loading of TRU wastes into this waste form can be substantially greater than the loading currently acceptable for the cemented waste form. The increase in TRU waste loading will dramatically reduce the volume of waste currently produced. The process is currently under development in pilot scale at TA-55. LANL is working cooperatively with INEEL to design and install the vitrification system within PF-4. This system should be operational in FY 2001.
- **Improved Ion Exchange Resins.** New ion exchange resins are being developed and synthesized with improved absorption characteristics for plutonium and americium. These resins could replace existing resins in the nitric acid processing stream. Use of these resins will increase the amount of plutonium and americium recycled and will significantly reduce the concentrations of these actinides in the cementation evaporator bottoms that can be added to each drum and still meet thermal wattage limits for WIPP certification. Pilot-scale column and radiolytic stability testing of the new resins still is required.
- **Electrochemical Ion Exchange.** After chemical species are loaded onto typical ion exchange resin systems, they usually are eluted with strong acids or bases. The use of these eluents increases the amount of total dissolved solids in the aqueous waste stream requiring treatment. Electrochemical ion exchange utilizing an electric current to generate the hydrogen ion concentrations required for elution eliminates the need for acids. Implementation of this system will reduce the total dissolved solids present in the aqueous waste streams dramatically.

#### **Initiative T-5: Caustic Liquids**

- **Scintillating In-Line Alpha Counter.** The scintillating in-line alpha counter is a real-time process monitor developed for measurement of process solution concentrations. This allows operators to make rapid decisions concerning the need to recycle process solutions to reduce effluent concentrations further. This real-time decision-making capability can reduce the quantity of hydroxide cake that exceeds the STLs and thus requires immobilization or reprocessing. By installing multiple monitors at various points in the process stream, plutonium recovery rates can be

optimized. Optimization of the plutonium recovery rates reduces the amount of plutonium that must be discharged to the RLWTF. Reducing these discharges will decrease the amount of TRU waste generated at the RLWTF.

- **Waste-Stream Polishing.** A solution containing small quantities of dissolved actinides is passed through a column of inert particles coated with actinide extractive organic ligands. The result is the separation of the effluent stream into a small volume with high actinide concentrations and a decontaminated aqueous effluent stream. This process has been tested on the high-concentration (5 to 8M) hydrochloric acid streams from the solvent extraction process. The large scale synthesis of the new actinide ligands and full-scale demonstration at TA-55 are required.
- **Improved Dissolution Technologies.** Increasing the recovery efficiency of the aqueous chloride process is dependent on the ability to dissolve the feedstock matrices more fully to free the plutonium. Improved dissolution will decrease the quantity of residues that must be reprocessed or discarded, thus reducing the TRU waste stream. Additional investigation and R&D are needed to identify and optimize new dissolution technologies. This is a relatively new area of research and needs to be more fully developed.

#### **Initiative T-6: Acidic Liquids**

- **Scintillating In-Line Alpha Counter.** The scintillating in-line alpha counter is a real-time process monitor developed to measure process solution concentrations. This allows operators to make rapid decisions concerning the need to recycle process solutions and further reduce effluent concentrations. This real-time decision-making capability can reduce the quantity of waste that exceeds the STLs and thus requires immobilization or reprocessing. By installing multiple monitors at various points in the process stream, plutonium recovery rates can be optimized. Optimization of the plutonium recovery rates reduces the amount of plutonium that must be discharged to the RLWTF. Reducing these discharges will decrease the amount of TRU waste generated at the RLWTF.
- **Nitric Acid Distillation.** Installation of a fractional distillation column is currently underway. This will provide the capability to concentrate the spent 3 to 7 M nitric acid waste stream from the aqueous nitrate process to 12 to 15 M for reuse. Reuse of the nitric acid will reduce the nitrate concentration in the TA-55 acid waste stream, helping the TA-50 RLWTF to achieve the National Pollutant Discharge Elimination System (NPDES) permit level for nitrate ion. This is a significant improvement that will help satisfy a compliance order from the NMED.
- **Polymeric Filtration.** This process selectively recovers valuable or regulated metal ions from waste water. Water-soluble chelating polymers are designed to bind selectively with metal ions in aqueous solutions. The polymers have a sufficiently large molecular weight that they can be separated and concentrated using commercially available ultrafiltration technology. A series of tests with these units has been performed at TA-55 on actual wastes, including  $^{238}\text{Pu}$ . A pilot-scale system has been installed in a PF-4 glovebox for demonstration testing. Three of four units

now may be deployed at TA-55. The cost to implement a single polymer filtration unit is \$750,000.

- **Improved Dissolution Technologies.** Increasing the recovery efficiency of the nitrate process is dependent on the ability to dissolve the feedstock matrices more fully to free the plutonium. Improved dissolution will decrease the quantity of residues that must be reprocessed or discarded, thus reducing the TRU waste stream. Additional investigation and R&D is needed to identify and optimize new dissolution technologies.

## 5.0 Low-Level Waste

### 5.1 Summary

Low-Level Waste (LLW) is defined in DOE Order 5820.2A (DOE, 1988) as waste that contains radioactivity and is not classified as high-level waste, TRU waste, spent nuclear fuel, or II(e)2 by-product materials (for example, uranium or thorium mill tailings). Test specimens of fissionable material irradiated only for research and development and not for the production of power or plutonium may be classified as LLW, provided that the activity of TRU waste elements is  $<100$  nCi/g of waste.

Disposal of LLW is governed at the Laboratory by the LANL Waste Acceptance Criteria (WAC), which also drives LLW reporting requirements. These criteria place limits on the physical, chemical, and radiological characteristics of acceptable LLW, and are developed from DOE Orders, federal, and state laws and requirements, and site characteristics. Laboratory Implementation Requirement (LIR) LIR404-00-05, *Managing Radioactive Waste*, provides guidance specific to LLW; and LIR404-00-02, *General Waste Management Requirements*, contains waste minimization requirements.

### 5.2 LLW Minimization Performance

DOE has implemented goals for waste minimization. Figure 5-1 shows the success for LANL in achieving the DOE goal for FY99 of a 50% reduction in routine LLW generation. The DOE environmental leadership program will go beyond compliance requirements and be based on continuous and cost-effective improvements. To achieve these goals, the Laboratory must use pollution prevention processes that lead to minimal waste generation and lowest life-cycle costs. Figure 5-1 depicts LLW volumes from 1994 through 1999.

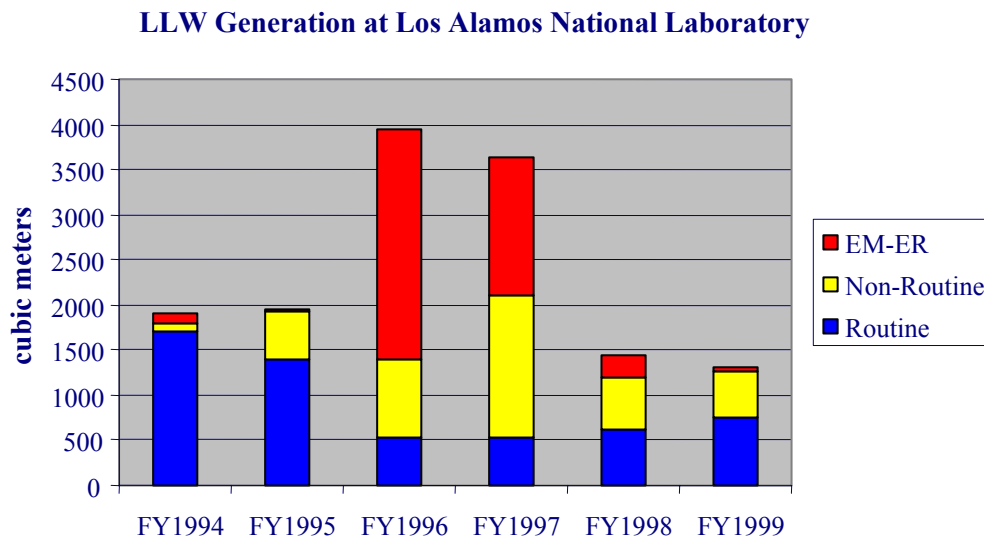


Figure 5-1. Comparison of waste volumes for FY94-FY99.

The low-level radioactive waste reduction goal for FY 2005, is to reduce waste from routine operations by 80% by 2005, calculated using the 1993 calendar year (CY) as the baseline, as required by DOE.

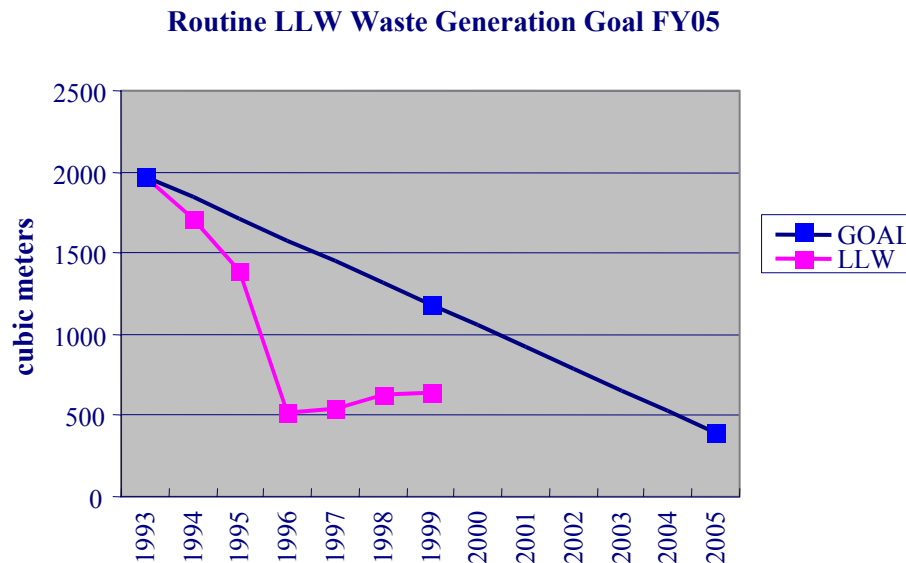


Figure 5-2. FY 1999 and FY 2005 routine generation goal with FY 1999 actuals.

In addition to tracking overall waste generation values, the following items will be tracked to ensure that the performance measures can be met.

**A. Combustible LLW Stream**

- Track the amount of launderable materials used at the Laboratory.
- Track the TA-54 waste verification results to ensure that compactable waste is being segregated from non-compactable waste.
- Track the volume of wood products used in RCAs.
- Track the amount of material processed through the Green is Clean (GIC) facility.

**B. Noncombustible LLW Stream**

- Track reuse databases to ensure that excess equipment is being utilized.

**C. LLW Scrap Metal Waste Stream**

- Track the quantity of scrap metal recycled.

### 5.3 Waste System Description

Figure 5-3, below, depicts the process map for LLW generation at the Laboratory and a pie chart showing percent of total LLW stream comprised of each category, combustible waste, noncombustible waste, and scrap metal.

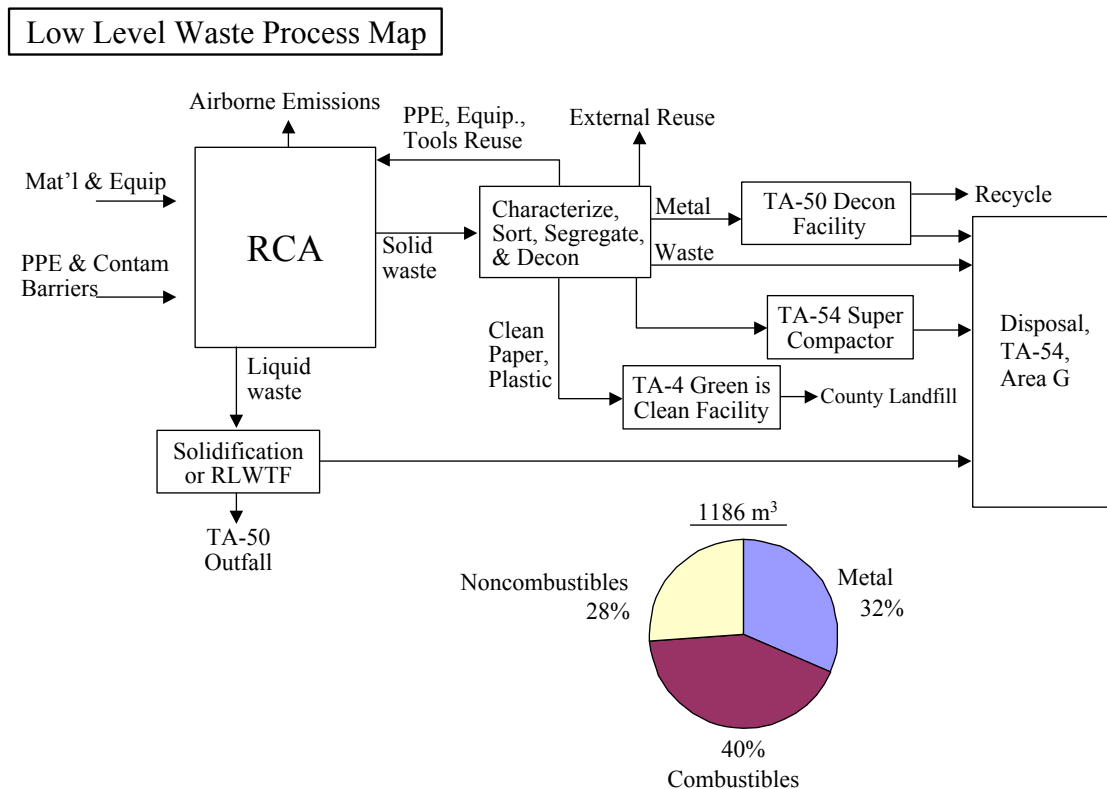


Figure 5-3. Top-level LLW process map and waste streams.

Materials, hardware, equipment, personnel protective equipment (PPE), and contamination barriers (paper and plastic) are used in RCAs. After these items are no longer needed, they leave the RCA after being sorted, segregated, and, if possible, decontaminated. Some PPE, equipment, and tools are reused at the Laboratory while some other equipment is sent offsite for reuse. Compactable waste is sent to the TA-54, Area G, compactor for volume reduction before disposal. Much of the waste leaving RCAs is not radiologically contaminated and can be surveyed to determine if the waste meets the radiological release criteria. If so, then it is recycled or disposed of as sanitary waste. Low-density waste is sent to the Green is Clean (GIC) Facility at TA-54, Area G, for verification that it meets the radiological release criteria. It then is sent to the County Landfill for disposal. Scrap metal items for verification are sent to the TA-50 Decontamination Facility, where the items are assayed to ensure that they meet radiological release criteria, are decontaminated if required, and are then recycled.

Solid LLW generated by the Laboratory's operating divisions is characterized and packaged for disposal at the on-site LLW disposal facility at TA-54, Area G. LLW minimization strategies are intended to reduce the environmental impact associated with LLW operations and waste disposal, by reducing the amount of LLW generated and/or minimizing the volume of LLW that will require storage or disposal on site. LLW minimization is driven by the finite capacity of the on-site disposal facility and by the requirements of DOE Order 5820.2A and other federal regulations and DOE Orders.

A 1998 analysis of the LLW landfill at TA-54, Area G, indicated that at previously planned rates of disposal, the disposal capacity would be exhausted in a few years. Reduction in LLW generation has extended this time to approximately five years; however, potentially large volumes of waste from planned construction upgrades could rapidly fill the remaining capacity. With regulatory approval of the Site-Wide Environmental Impact Statement (SWEIS) through a DOE Record of Decision in the fourth quarter of 1999, construction of additional disposal sites is now allowed. Additional sites for LLW disposal at Area G would provide on-site disposal for an additional 50 to 100 years. However, cost considerations and public acceptance issues may call for a delay by a few years, for construction of additional disposal sites.

Liquid LLW typically is generated at the same facilities that generate solid LLW. It is transferred through a system of pipes and by tanker trucks to the RLWTF at TA-50, Building 1. The radioactive components are removed and disposed of as solid LLW. The remaining liquid is discharged to a permitted outfall.

NMT, CST, Engineering Sciences and Applications (ESA), and E-Divisions produce the bulk of Laboratory LLW (see Figure 5-4). NMT Division waste is generated from the production and maintenance of the nuclear weapons stockpile. CST Division waste is produced from a wide variety of Laboratory operations. ESA Division waste is produced from the manufacture of components for the nuclear weapons complex. E-Division waste is produced through the implementation of environmental restoration (ER) projects and from the operation of the TA-54, Area G, LLW disposal site. Unlike the other waste produced, that produced from decommissioning and ER projects will be disposed of at the Envirocare site in Utah, or in situ, and is not addressed in this LLW section.

**LLW Generation FY99**  
(without E-ER non-routine and FWO-SWO non-routine)

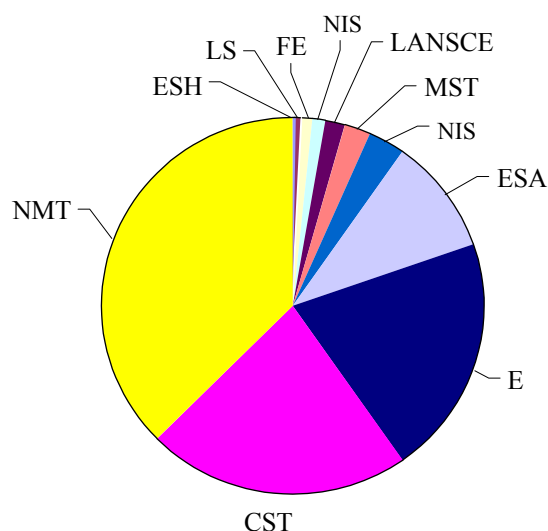


Figure 5-4. LLW generation by Laboratory organization.

The current cost for disposal of LLW at the Laboratory is \$2586/m<sup>3</sup> for non-compactable waste and \$1036/m<sup>3</sup> for compactable waste. During 1993, a total of ~1140 m<sup>3</sup> of compactable and a total of ~1700 m<sup>3</sup> of non-compactable LLW were disposed of at the Laboratory (not including ER waste). At today's disposal costs, these volumes would represent a total cost to the Laboratory of approximately \$7 million/year. Fortunately, pollution prevention and waste minimization activities at the Laboratory have reduced the size of the waste stream substantially since 1993. The 1999 LLW disposal cost for the Laboratory is approximately \$3 million/year.

The quantity of LLW generated at the Laboratory varies from year to year. The volume (in cubic meters) of non-ER, non-legacy waste is shown in Figure 5-5.

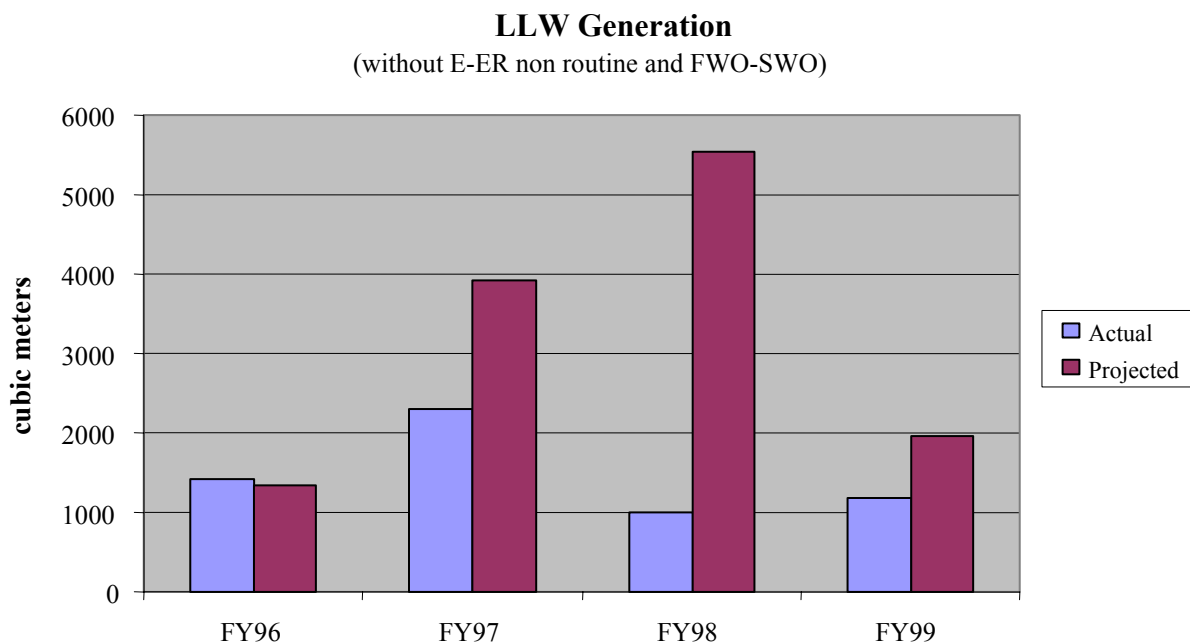


Figure 5-5. LLW generation trend vs. FWO-SWO ten-year plan projections.

LLW is comprised of various waste streams which are categorized as combustible LLW, noncombustible LLW, and scrap metal LLW. LLW is generated when materials, equipment, air, and water brought into RCAs to perform work are radiologically contaminated, and then are removed from the facility in the form of air emissions, solid LLW, or aqueous LLW. The waste streams in each solid LLW category are listed below and are defined in Section 5.5, Low-Level Waste Stream Descriptions.

#### A. Combustible LLW

- Plastic bags
- Plastic sheeting/Herculite
- Plastic bottles

- Disposable wipes
- Paper
- Wood
- HP smears/swipes
- Tape
- Disposable gloves

**B. Noncombustible LLW**

- Glassware
- Laboratory equipment
- Building service/utilities equipment, including tools
- Electronic equipment

**C. Scrap Metal: “Scrap metal” is also the waste stream.**

Figure 5-6 depicts the components making up the LLW stream at the Laboratory.  
(Waste produced from ER and decommissioning operations is not included in this figure.)

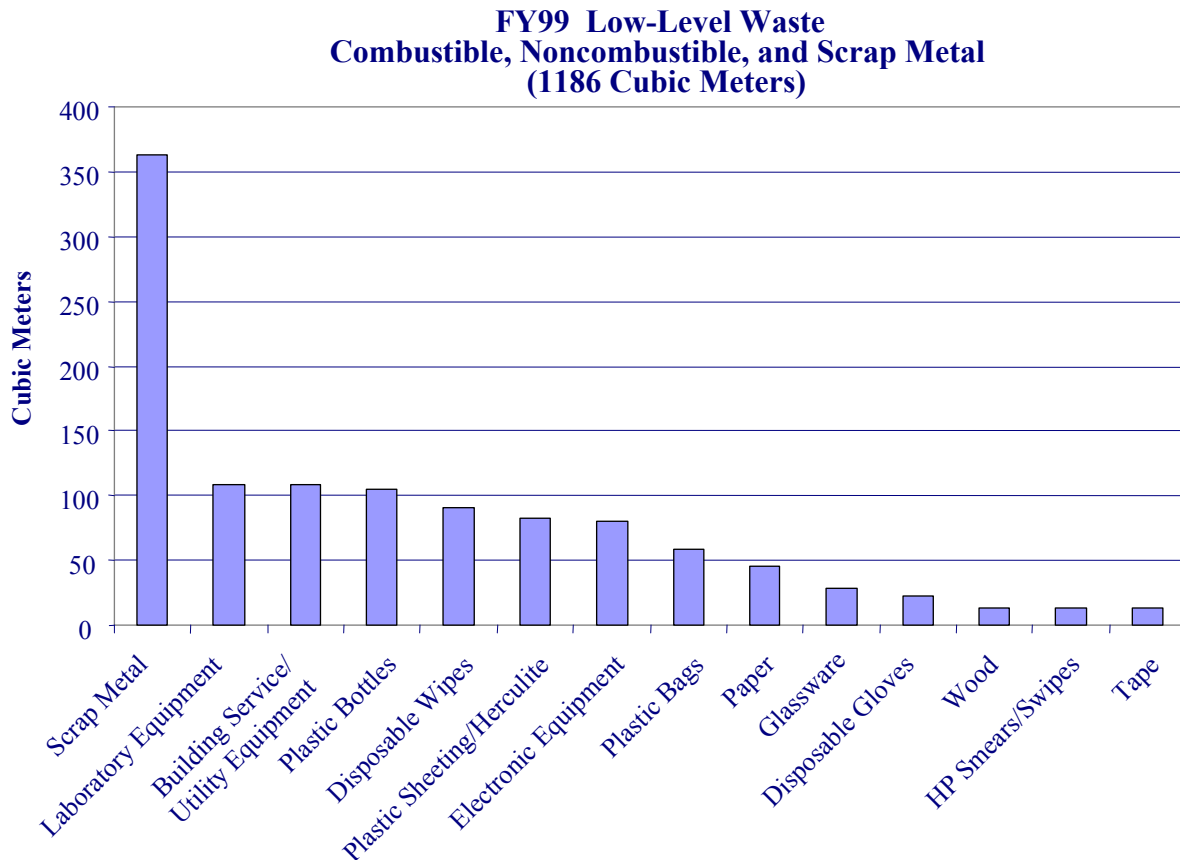


Figure 5-6. LLW streams.

## 5.4 Issues

**Issue 1: LLW Disposal Capacity.** As the result of an environmental assessment completed at the end of FY99, additional sites for LLW disposal at TA-54 Area G have been approved. These additional sites would provide on-site disposal of LLW for an additional 50 to 100 years. However, cost considerations and public acceptance issues call for a delay in the construction of additional disposal sites. Current disposal capacity will be expended in approximately five years; therefore, public sentiment and cost issues need to be resolved in the next few years to allow time for construction. If off-site disposal of LLW becomes necessary, waste costs will increase significantly.

**Issue 2: LLW Release Criteria.** Every waste item leaving an RCA is assumed to be radiologically contaminated unless there is acceptable proof that the item has remained contamination free, and/or radiological surveys verify that the item meets the criteria specified in DOE Order 5400.5. The specified criterion, however, applies only to surface-contaminated objects. There are no criteria specified for porous or activated objects that may be volume contaminated (e.g., wood planks). In addition, many surface-contaminated objects cannot be surveyed, due to surfaces that are inaccessible to the available survey instrumentation, and must be treated as volume contaminated items.

DOE Order 5400.5 allows the case-by-case establishment of volume contamination criteria; however, because of the lengthy timeframes required to acquire State regulatory approval, the establishment of criteria on a case-by-case basis is not practicable. ANSI has approved a new standard (ANSI N13.12) that establishes volume contamination limits, and DOE and State acceptance of this standard would avoid the disposal of substantial amounts of LLW that could be recycled as scrap metal. DOE and State approval have not been granted at this time.

## 5.5 Low-Level Waste Stream Descriptions

The low-level waste streams at the Laboratory arise from processes at various Laboratory sites and in some cases are interrelated. For example, significant quantities of Laboratory equipment (e.g., computers, etc.) contain circuit boards that must be disposed of as MLLW. The goal for the TRU program is to lower the radiation levels of gloveboxes from TRU to LLW levels through decontamination, and the goal for the LLW program is to use all means possible to release the maximum materials for recycle, reuse, or sanitary waste disposal. LLW streams are categorized below as combustible, noncombustible, or scrap metal. The categorized waste streams and their definitions follow.

### A. Combustible Waste Streams

Materials from combustible waste streams used to accomplish programmatic work in RCAs are processed as LLW when they are removed. Combustible materials make up approximately 40% of the total LLW produced at the Laboratory annually. Combustible LLW streams with their definitions follow, presented in descending order by volume.

- **Plastic Bottles (110m<sup>3</sup>):** Plastic bottles are used to contain aqueous samples and to move aqueous material from one RCA to another.
- **Disposable Wipes (95m<sup>3</sup>):** Disposable wipes consist of any absorbent product (paper towels, wipes, cheese cloth, etc.) used as a cleaning aid or to absorb aqueous materials. The majority of these wipes are either used as a laboratory aid or are contaminated during cleanup activities.
- **Plastic Sheeting/Herculite (85m<sup>3</sup>):** Plastic sheeting is used for contamination barriers. Plastic sheeting typically is placed on the floor areas or used to build containment structures around equipment to prevent the spread of radioactive contamination and to ease cleanup activities.
- **Plastic Bags (62m<sup>3</sup>):** Plastic bags are used to package waste for disposal and to transport materials from one RCA to another.
- **Paper (47m<sup>3</sup>):** Office paper is used for recording data, working procedures, etc. Other forms of paper, such as brown paper wrapping material, are used as temporary contamination barriers to prevent the spread of contamination and to ease cleanup activities.
- **Disposable Gloves (24m<sup>3</sup>):** Disposable gloves are an essential PPE requirement when working in RCAs. Disposable gloves offer a high level of dexterity. If more protection is required, a heavier, launderable pair of gloves is worn over the disposable gloves.
- **Wood (14m<sup>3</sup>):** Wood is used as a construction material to erect temporary containment structures. Wood also is introduced into RCAs in the form of wooden pallets, scaffolding planks, and ladders. Wood also is used to support heavy objects being packaged for disposal to ensure that the objects do not shift in their packaging container during transport.
- **Tape (14m<sup>3</sup>):** Tape is used for a variety of purposes within RCAs. Tape is used as an aid to seal PPE. It is also used to fix plastic and paper contamination barriers in place.
- **HP Smears/Swipes (14m<sup>3</sup>):** This material consists of filter paper material and large “masslin” swipes used to monitor removable contamination levels within RCAs.

Documented acceptable knowledge (AK) waste that is not contaminated is segregated, verified clean, and disposed of as sanitary waste at the County Landfill. The remaining low-level combustible waste is segregated further as compactable or non-compactable waste. Compactable waste is sent to the TA-54, Area G, compactor for volume reduction, approximately a one-to-five compaction, and then disposed of as LLW. The non-compactable waste stream is sent directly to disposal.

A disposal process map for these compactable and non-compactable combustible Laboratory materials is depicted in Figure 5-7, below.

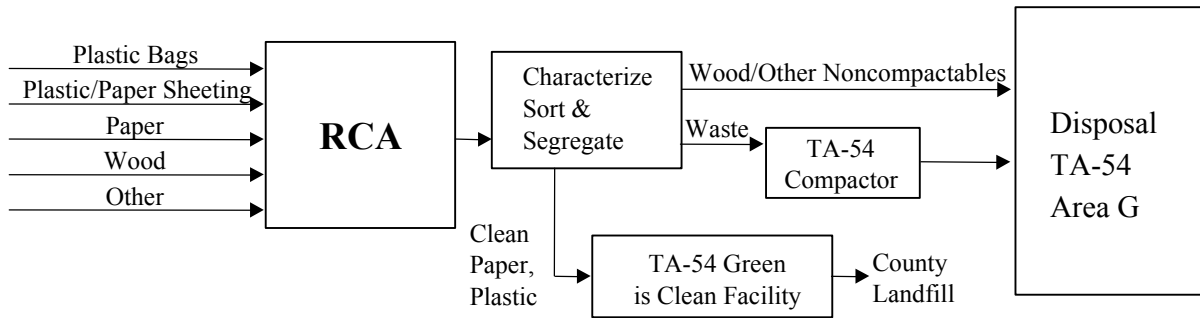


Figure 5-7. Combustible waste stream: compactable and non-compactable.

Breaking down the combustible waste stream further, the three major categories of paper entering RCAs are contamination barriers, disposable wipes, and office paper. Typically, AK can be used to declare office paper “clean,” and it can be sent to the TA-54 GIC Facility for verification and disposal at the County Landfill.

Office paper used for data collection or printouts of working procedures is often archived for a period of time before disposal. Maintaining the AK and documentation necessary to declare office paper “clean” after being archived can be more difficult and could result in unnecessary disposal as LLW.

Paper contamination barriers, generally in the form of brown wrapping paper, are brought into an RCA to provide temporary contamination barriers and then are removed for disposal. Disposable wipes are used as both a laboratory and a cleaning aid. Disposable wipes usually do become contaminated and require disposal as LLW.

The processing for paper as a compactable waste stream is depicted in Figure 5-8.

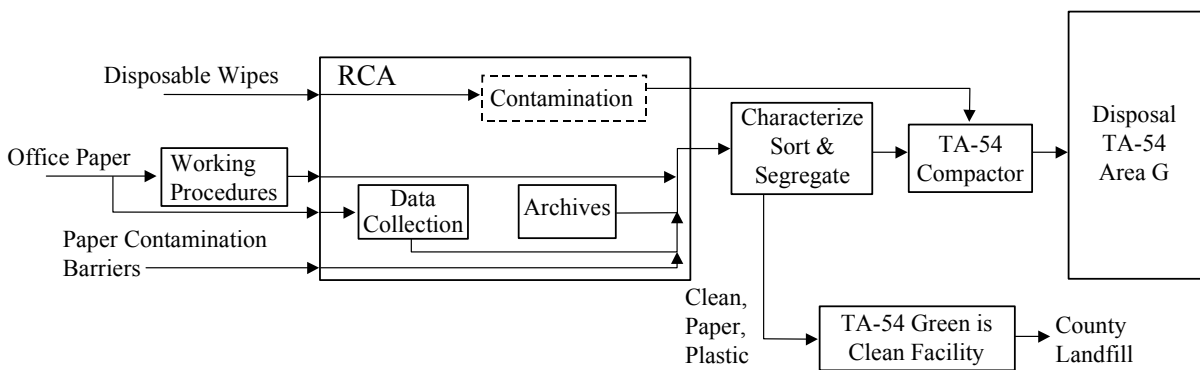


Figure 5-8. Compactable waste stream.

## B. Noncombustible Waste Streams

Noncombustible materials make up approximately 28% of the total LLW produced at the Laboratory annually. Noncombustible LLW streams are defined in the following list.

- **Laboratory Equipment (114 m<sup>3</sup>):** This waste stream consists of a variety of laboratory equipment that is either outdated, no longer functional, or for which a use cannot be found. This waste stream consists of hot plates, furnaces, centrifuges, computers, and a variety of miscellaneous analytical instrumentation.
- **Building Service/Utility Equipment and Tools (114 m<sup>3</sup>):** This waste stream consists of a variety of work tools as well as equipment used to provide basic facility services, such as pumps, ventilation units, and compressors. This equipment generally is removed during facility maintenance or upgrade activities.
- **Electronic Equipment (80 m<sup>3</sup>):** This waste stream consists of a variety of equipment including computer equipment, and miscellaneous laboratory and building services, and utilities electronic equipment. This equipment is expensive to dispose of because it is difficult to characterize, and many of the components are classified as hazardous waste, so either must be disposed of as Mixed Low Level Waste or be recycled.
- **Glassware (30 m<sup>3</sup>):** This waste stream consists of laboratory glassware that can no longer be used because it cannot be cleaned well enough to prevent the cross contamination of samples.

When the above materials are brought into RCAs and used to accomplish programmatic work, they are processed as LLW when they are removed from the RCAs. Materials that AK indicates is not contaminated, are segregated, reused internally, or are sent offsite for reuse or recycle.

The process map for Laboratory noncombustible materials is depicted in Figure 5-9.

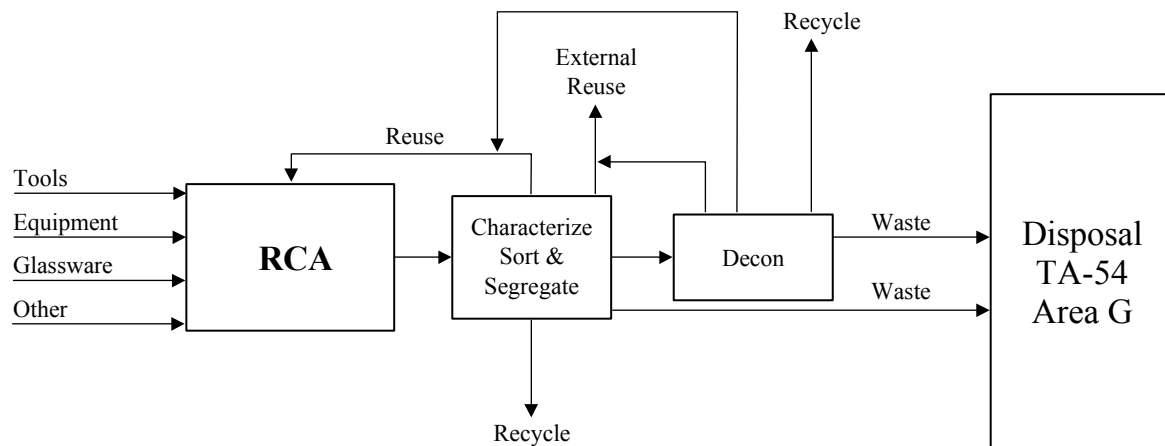


Figure 5-9. Process map for noncombustible waste streams.

Materials that are contaminated or for which AK does not exist are decontaminated and recycled or reused, or are disposed of as LLW. A further breakdown of the noncombustible waste stream is depicted in Figure 5-10.

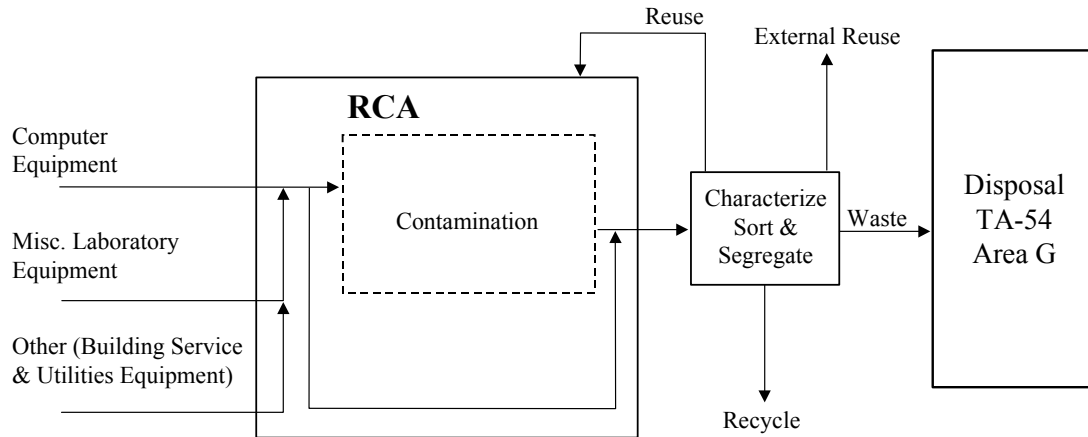


Figure 5-10. Noncombustible waste stream.

### C. Scrap Metal Waste Stream

- Scrap Metal (380 m<sup>3</sup>):** This waste stream consists of a large variety of items including structural steel, piping, sheet metal objects, lab furniture, gloveboxes, and other scrap metal items. Typically, the majority of this material is produced during facility upgrade activities. A process map for the Scrap Metal waste stream is depicted in Figure 5-11.

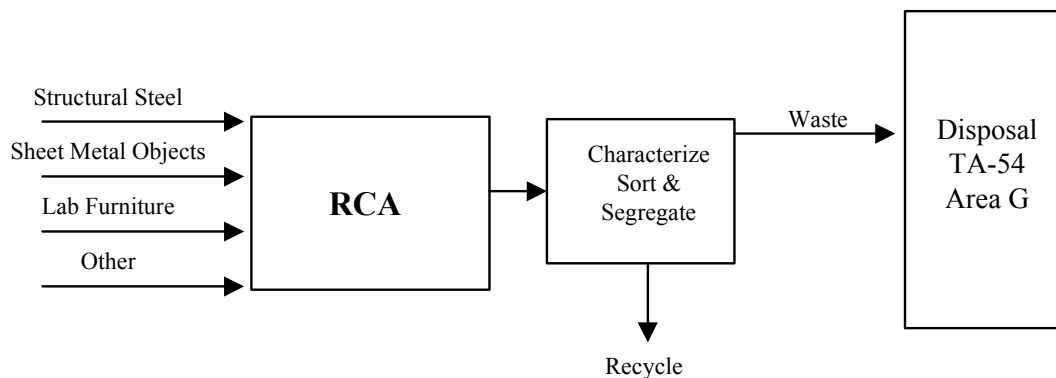


Figure 5-11. Process map for the scrap metal waste stream.

## 5.6 Initiatives

For the LLW streams, the Laboratory is aggressively pursuing initiatives and action plans with milestones, concentrating on developing processes and programs for advancing the LLW program goal of reducing the volume of Laboratory LLW that requires disposal. The LLW Stream Goal is presented here in Figure 5-12.

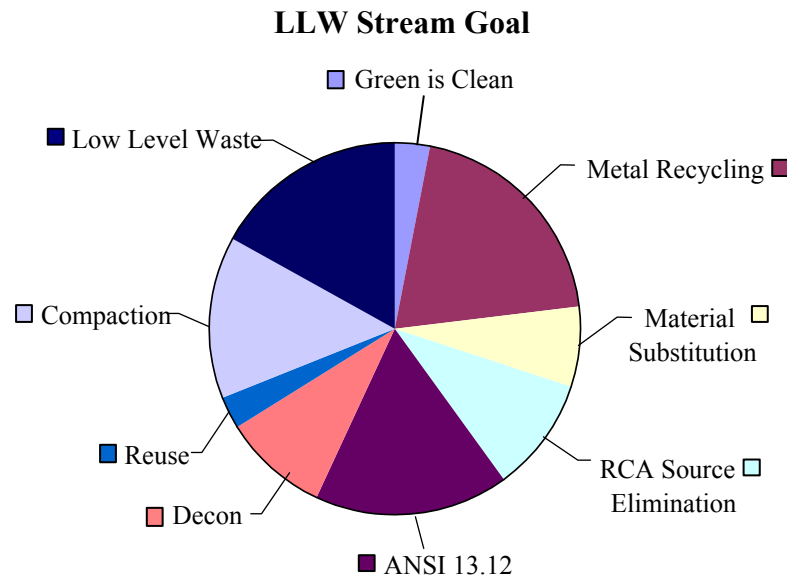


Figure 5-12. LLW goal: 500 m<sup>3</sup> - 17% of 1993 generation rate of ~1900 m<sup>3</sup>.

The following waste reduction initiatives have been identified for reducing the LLW streams and are briefly described below. Action plans to support each initiative, with additional information on milestones, status, and avoidance information is presented in Appendix 1B, Low-Level Waste Initiatives.

### **Initiative L-1: RCA Source Reduction**

- **Minimize the amount of material entering RCAs.** Because the majority of materials entering RCAs are critical to programmatic activities, it is difficult to utilize source-reduction techniques. However, the amount of material entering an RCA can be minimized by unpacking all items before transferring them into an RCA, thereby reducing the LLW stream by several hundred cubic meters per year.
- **Reduce RCA floor space.** The Laboratory minimized equipment and materials in RCAs by reducing the RCA floor plan footprint by ~150,000 ft<sup>2</sup>, which was estimated to reduce the LLW stream by 340 m<sup>3</sup>/yr.
- **Monitor equipment in RCAs.** Placing some type of monitoring device inside each piece of equipment may make it possible to determine easily whether the equipment is internally contaminated and whether it can be reused or recycled.

- **Substitute metal pallets, ladders, and construction materials for those made of wood.** Eliminate the use of wood within RCAs, except to package LLW safely for transport. Metal objects can be surveyed easily for radiological contamination, be decontaminated as necessary, and then be reused or recycled.
- **Use air-dry dishwashing systems for laboratory glassware.** Used whenever possible, this would eliminate the use of disposable wipes to dry laboratory glassware. Disposable wipes make up ~8% of the LLW stream, however, the exact impact of using air-dry systems on the LLW stream currently is unknown
- **Use electronic devices such as computers, to view working procedures and for data collection inside RCAs.** Used wherever possible, this would replace the use of office paper to collect data inside RCAs, and eliminate bringing in paper working procedures. It is estimated that implementation of this option could reduce the amount of office paper used by at least 50%. Implementation will require addressing issues pertinent to signatures of record, identifying better viewing systems for documentation (systems that allow for handwritten notes, etc.).

### **Initiative L-2: Improve Characterization Processes and Techniques**

- **Increase the amount of material that can be identified as LLW.** Develop improved characterization techniques to increase the quantity of material that can be recycled. TRU radioisotope contamination is very difficult to detect because of the small range of alpha particles in the air. New characterization techniques are needed to enhance the ability to detect alpha particles so that the amount of equipment that can be reused or recycled can be increased.
- **Improve characterization to prevent sanitary waste from inside RCAs being sent automatically for LLW disposal.** Increase the amount of AK material for recycle or disposal as sanitary waste.
- **Adopt ANSI N13.12 to establish volume contamination criteria and to facilitate the characterization process.** Adoption of this standard would substantially increase the amount of material that could be reused or recycled.

### **Initiative L-3: Improve Acceptable Knowledge (AK) Use and Documentation**

- **Use AK to simplify the characterization process.** Identify methods to improve acceptable knowledge and maintain AK on equipment that has been inside an RCA for extended periods of time, to determine whether equipment can be reused or recycled.

**Initiative L-4: Increase Quantity of Material Verified at the Green is Clean (GIC) Sort and Segregate Facility**

- **Increase the quantity of combustible materials sent to the GIC Facility including, but not limited to, paper and plastic.** By increasing the amounts of paper and plastic sent to the GIC Facility for verification and release to the County Landfill, it is estimated that 50% of the combustible waste stream could be avoided. In addition, increase AK materials sent to the GIC Facility for verification and free-release, as well as “suspect” materials to be verified for possible free-release.

**Initiative L-5: Increase Usage of Compaction Facility**

- **Increase lab-wide usage of established TA-54 Compaction Facility.** Use the Compaction Facility established at TA-54 to reduce the waste volume of the compactable fraction of the combustible and noncombustible waste streams. Ensure generators are aware of extensive capabilities for compaction to 200 tons. It is estimated that this facility will reduce the volume of the combustible waste stream by 80%. At current waste generation rates, it is estimated that this will reduce this waste stream by  $\sim 300 \text{ m}^3/\text{yr}$ .

**Initiative L-6: Increase Usage of the TA-50 Decontamination Facility: a Central Facility for Characterization, Sorting, Segregation, and Decontamination of Equipment and Scrap Metal**

- **Characterize, sort, segregate, and decontaminate equipment and scrap metal.** To assist waste generators and encourage recycling, a centralized facility has been established at the TA-50 Decontamination Operation. This activity is essential to minimize LLW disposal. An extensive program to encourage the characterization, sorting, segregation, and recycling of scrap metal at the Laboratory has been in place for several years, with a total of  $2800 \text{ m}^3$  of scrap metal being recycled by the end of FY98, including  $120 \text{ m}^3$  in FY98. Approximately  $35 \text{ m}^3$  of equipment has been assembled for sorting, segregation, and decontamination activities that will result in a large fraction of this equipment being recycled.
- **Develop improved characterization techniques to increase the amount of material that can be recycled.** TRU radioisotope contamination is very difficult to detect because of the small range of alpha particles in the air. New characterization techniques are needed to enhance the ability to detect alpha particles so that the amount of equipment that can be reused or recycled can be increased.
- **Develop improved decontamination capabilities for tools and equipment.** Approximately 50% of the equipment leaving an RCA requires decontamination before the equipment can be reused or recycled. Currently, only manual decontamination techniques are available to process this equipment, and currently, only a small fraction of the equipment that could be decontaminated is being reused or recycled.

- **Sponge jet decontamination system for metal.** A sponge-jet decontamination system was pilot tested at the Laboratory in FY99. A total of 105 m<sup>3</sup> of LLW disposal volume was avoided, and 15 m<sup>3</sup> of scrap metal was recycled.

#### **Initiative L-7: Promote Contamination Avoidance**

- **Use protective coatings and/or other contamination barriers to ensure that equipment is not contaminated.** Ensure that materials entering an RCA can leave the RCA as “clean” and be reused or recycled. Implementation of this option requires the identification and use of contamination barriers, such as environmental cabinets for computers and strippable coatings for other equipment.
- **Use the property accounting/management system to ensure need and alternatives are evaluated before equipment is introduced into RCAs.** Use the property management system to ensure that only necessary equipment, avoiding duplication, is brought into RCAs and that it is first evaluated properly to determine what methods can be used to prevent contamination.

#### **Initiative L-8: Provide Launderables in RCAs**

- **Use launderable PPE.** By using launderable PPE, the Laboratory has virtually eliminated the use of disposable PPE and the waste volume associated with its disposal.
- **Substitute launderable bags for plastic bags.** This would replace with launderable bags, the plastic bags currently used to transport materials from one RCA to another. There is no added cost associated with this change as a laundry contract is already in place with a vendor, to supply launderable materials to the Laboratory.
- **Substitute launderable contamination barriers for plastic sheeting and paper.** Replace the plastic sheeting and paper used as contamination barriers inside of RCAs with launderable barriers (cloth tarps, etc.). Although a laundry contract is in place with a vendor to supply launderable materials to the Laboratory, sufficient contamination barrier options are not available currently. A wider selection of contamination barriers will be identified and added to the materials available through the existing laundry contract. It is estimated that this waste stream contributes up to 200 m<sup>3</sup>/yr of waste to the LLW stream.
- **Use launderable rags whenever possible.** Replace disposable wipes with launderable rags for maintenance or other activities where this substitution is possible. Because of potential cross contamination, launderable rags cannot be used in some laboratory operations. Launderable rags are available through the existing laundry contract. The use of disposable wipes accounts for ~8% of the material in the LLW stream. It is estimated that the substitution of launderable rags may reduce this waste stream by 50%.

- **Substitute launderable Velcro strips and bands for tape currently used to seal PPE openings, (e.g., at sleeves and closings).** Availability will have to be determined. The actual impact on the LLW stream is unknown.

#### **Initiative L-9: Promote Equipment Reuse and Exchange**

- **Use an internal and external database system to encourage the reuse of equipment.** A database has been established to identify equipment that can be reused internally or be sent offsite for reuse, providing an easily accessible resource to individuals or organizations that may need this equipment.
- **Increase reuse rates by reconditioning equipment.** Closely linked to the opportunity presented by the available-equipment database is the reconditioning of equipment to enhance reuse rates. Equipment currently being disposed of can be reconditioned and reused internally or sent off site for reuse.
- **Promote the Russian Recycle Program.** Equipment and electronic devices not reused within the Laboratory are donated to the Russian nuclear industry for reuse.

#### **Initiative L-10: Construction Waste Minimization**

- **Modify existing and future construction contracts.** Include waste minimization specifics. Ensure that waste generated during construction or upgrade projects is minimized.

#### **Initiative L-11: Increase Asphalt and Concrete Crusher Usage**

- **Increase asphalt and concrete crusher usage.** Increase usage of the purchased crusher to process the large amounts of asphalt and concrete debris generated during the decommissioning of facilities at the Laboratory. Currently it is being used by the decommissioning organization to reduce the volume of concrete debris. After processing, this material can be buried in place or reused, reserving additional valuable disposal capacity at the TA-54, Area G disposal facility. However, a reuse pathway for asphalt has not been developed at this time.

#### **Initiative L-12: DX Confined Testing**

- **Promote DX confined testing for depleted uranium (DU).** DX Division uses DU in tests conducted in the open environment. The DU contaminates the surrounding environment through airborne emissions. This initiative is to identify confined methods of testing to eliminate these emissions.

#### **Initiative L-13: RLWTF Improvements**

- **Modification of the RLWTF.** Improvements at this facility (e.g., ultra filters and centrifuge filters) for the treatment of the aqueous waste stream are estimated to reduce the solid waste disposed of by 50 m<sup>3</sup>/yr.

**Initiative L-14: Depleted Uranium (DU) Disposal**

- **DU disposal considerations.** The machining of DU creates DU chips and turnings that are pyrophoric which must be solidified for disposal. Solidification results in the creation of ~20 m<sup>3</sup> of LLW annually. Three options currently exist to reduce this waste stream: incineration at an offsite facility; oxidation and disposal at the Laboratory; and plasma melting of the DU chips with turning and recycling of the melted product. The current plan is to send this waste off site for incineration. Oxidation would decrease the current costs associated with incineration, however, plasma melting would completely eliminate this waste stream. Plasma melting is the preferred option.

**Initiative L-15: Require Procedure Changes**

- **Improve or develop procedures to encompass waste minimization techniques and improved characterization.** Develop comprehensive pollution prevention and waste minimization support documentation as new procedures or as improvements to existing documentation and programs, e.g., waste handling procedures and the Generator Waste Certification Program (GWCP).

**Initiative L-16: Implement Pollution Prevention/Waste Minimization Training Improvements**

- **Develop training to be required for the GWCP.** Develop comprehensive pollution prevention and waste minimization training for quarterly presentation. Require successful completion of training for Waste Management Coordinators (WMCs), as a minimum, and consider requiring it for waste generators and adding it to the technical evaluation standards for waste handlers/technicians. Require a Green Zia analysis as part of the GWCP certification process.
- **Improve or develop training.** Modify all waste handling training to encompass waste minimization and improved characterization techniques.

**Initiative L-17: Support Laboratory-Wide Cultural Change**

- **Support Laboratory-wide cultural change.** There are many underlying attitudes and global changes that need to be developed at the Laboratory to best support the commitment to pollution prevention and waste minimization. There needs to be a Lab-wide commitment to the Laboratory Implementation Requirements, and a commitment to making waste minimization, characterization, sorting, segregation, and decontamination inherent in daily work. It needs to become automatic for all personnel to include the waste minimization hierarchy in Step One of the 5-Step Process and to integrate it into ALL the other Steps as well. The Laboratory needs to pursue the solid integration of waste minimization, characterization, sorting, segregation, and decontamination into all work control processes at all facilities Laboratory wide. This would require adoption of these concepts into the very culture of the Laboratory.

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## **6.0. MIXED LOW-LEVEL WASTE**

### **6.1 Summary**

For mixed waste to be considered mixed low-level waste (MLLW), it must first meet the definition of low-level radioactive waste. Mixed waste is any waste containing both hazardous and source materials, special nuclear materials, or by-product materials. MLLW, therefore, contains both radioactive and RCRA waste. Because MLLW contains radioactive components, it is regulated by DOE Order 5820.2A (DOE, 1988). Because it contains RCRA waste components, MLLW is also regulated by the State of New Mexico through the Laboratory's operating permit, FFCO/STP (NMED 1995) and the Environmental Protection Agency (EPA). Materials in use that will be RCRA waste upon disposal are defined as hazardous materials.

Most of the Laboratory's routine MLLW results from Stockpile Stewardship and Management and from research and development (R&D) programs. Most of the non-routine waste is generated by off-normal events such as spills. Environmental Restoration and Waste Management Legacy operations, which also produce MLLW, are not included for the purposes of this roadmap. Typical MLLW items include contaminated lead shielding bricks, R&D chemicals, spent solution from analytic chemistry operations, mercury cleanup-kit waste from broken fluorescent bulbs and mercury thermometers, circuit boards from electronic equipment removed from a TRU waste radiation area, discarded lead-lined gloveboxes, and some contaminated water removed from sumps.

### **6.2 MLLW Minimization Performance**

DOE has implemented goals for waste minimization (WMin). Goals for FY99 were for DOE to achieve a 50% reduction in routine MLLW generation. Figure 6-1 shows Los Alamos National Laboratory's success in achieving this goal. The Department's environmental leadership program will go beyond compliance requirements and be based on continuous and cost-effective improvements. To achieve these goals, the Laboratory must use pollution prevention processes that lead to minimal waste generation and life-cycle costs.

The mixed low level radioactive waste goal is to reduce waste from routine operations by 80% by 2005, using the 1993 calendar year as the baseline. Figure 6-2, depicts the trend for waste generation from non-routine operations through 2005.

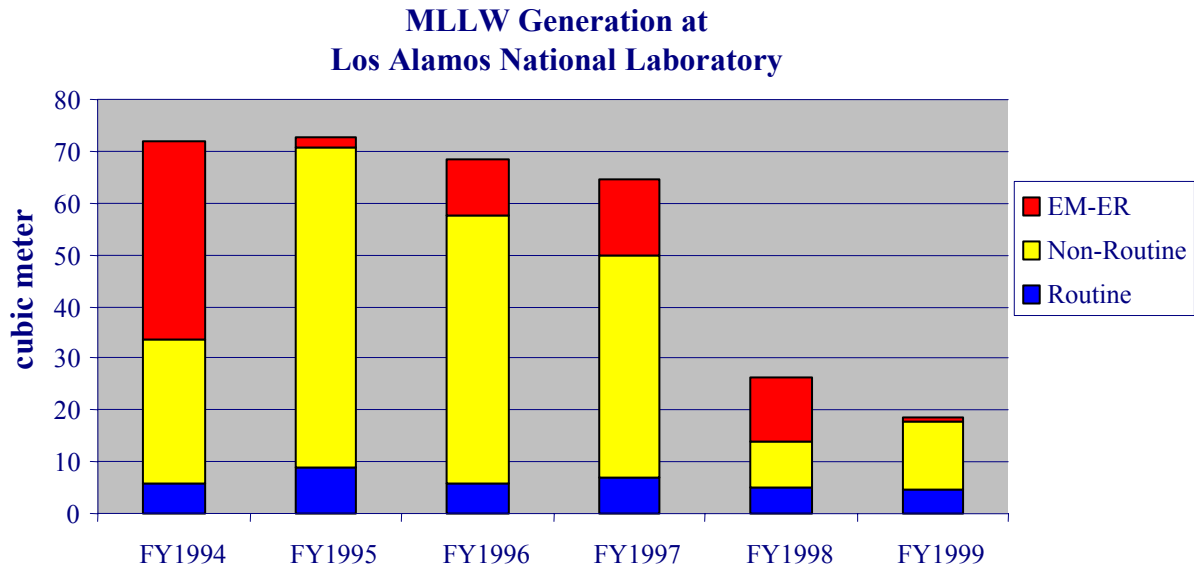


Figure 6-1. MLLW generation and projected generation.

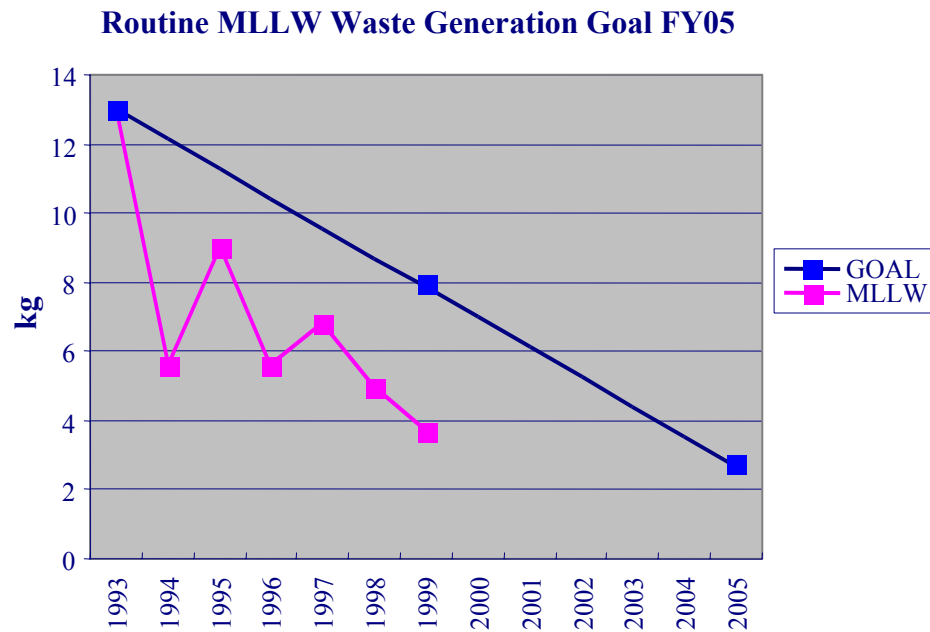


Figure 6-2. Mixed low-level waste stream generation down trend.

### 6.3 System Description

MLLW is generated in RCAs. Hazardous materials and equipment containing RCRA materials, as well as mixed low-level materials, are introduced into the RCA as needed to accomplish specific activities. In the course of operations, hazardous materials become

contaminated with LLW or become activated, becoming MLLW when the item is designated as waste. There are seven major MLLW streams: circuit boards, gloveboxes, lead parts, R&D chemicals, PPE, fluorescent tubes, and waste generated from spills and spill cleanup.

Typically, MLLW is transferred to a satellite storage area once generated. Whenever possible, mixed low-level materials are surveyed to confirm the radiological contamination levels, and if decontamination will eliminate either the radiological or the hazardous component, materials are decontaminated and removed from the MLLW category.

Generators of waste remaining as MLLW provide proper waste management and Department of Transportation documentation for SWO at TA-54, Area G or Area L to process the materials for storage, bulking, and transportation. From TA-54, MLLW is sent to commercial and DOE treatment and disposal facilities. The waste is treated/disposed of by various processes e.g., segregation of hazardous components, macroencapsulation, or incineration.

The top-level process map for MLLW is depicted in Figure 6-3.

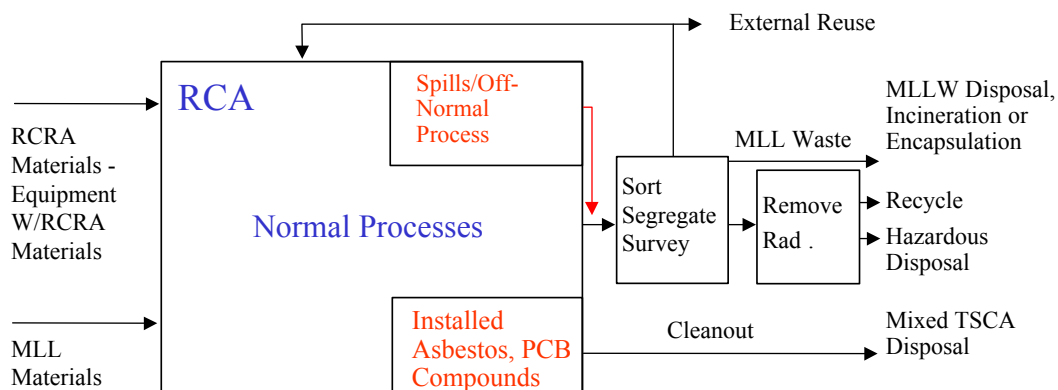


Figure 6-3. MLLW process map.

In some cases, the Laboratory procures spent mixed low-level materials from other DOE/commercial sites to avoid creating new MLLW. For example, the Los Alamos Neutron Science Center Experiment (LANSCE) is designing several new beam stops and shutters from lead. Rather than fabricating these from uncontaminated lead, LANSCE can receive these parts at no expense from GTS Duratek (formerly SEG), a company that processes contaminated lead from naval nuclear reactor shielding. Duratek fabricates parts at no cost to the Laboratory, as their fabrication costs are much less than the MLLW lead disposal costs would be.

The MLLW generated by division at the Laboratory is shown in Figure 6-4 without ER and SWO non-routine waste.

**MLLW Generation FY99**  
(without ER or SWO non-routine waste)

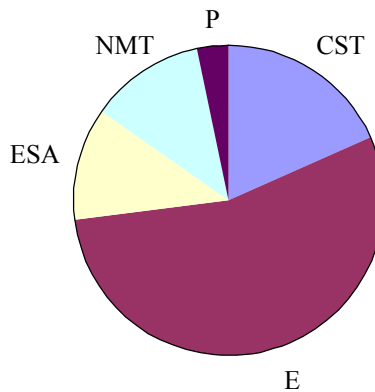


Figure 6-4. MLLW generation for FY99 by division.

The largest waste streams are spills, debris, gloveboxes, and PPE. These waste streams constitute ~80% of the MLLW waste type and are the primary targets for elimination. The waste streams were determined from 1995 through 1998 waste generation. The individual waste streams are listed below and are defined in Section 6.4.1 Waste Stream Descriptions.

- Spills
- Debris
- Gloveboxes
- PPE
- R&D Chemicals
- Lead
- Circuit Boards
- Fluorescent Tubes
- Other
- 

MLLW costs an average of \$88,305/m<sup>3</sup> to characterize, treat, and dispose of in FY99. SWO spent a total of \$5,684,000 managing newly generated MLLW in FY99. Table 6-1 summarizes the Laboratory's typical unit costs for MLLW disposal. Waste is disposed of either by incineration or by macroencapsulation and land disposal. Macroencapsulation involves potting the waste (typically solid parts) in a suitable plastic and creating a barrier around the waste.

**Table 6-1. Approximate Costs for MLLW Streams.**  
(Source, John Kelly, Solid Waste Operations)

Waste Type	Treatment Method	Treatment and Disposal Cost	Transportation Cost
Activated or inseparable lead	Macroencapsulation	\$15,000/m <sup>3</sup>	\$5000 per shipment
Surface-contaminated lead (amenable to onsite decon)	Decontamination at TA-50	Treatment—\$4000/m <sup>3</sup>	Nominal
Surface-contaminated lead (for offsite recycling)	Standard decontamination methods (bead blasting, acid dip, etc.) followed by recycling	\$8000/m <sup>3</sup>	\$5000 per shipment
RCRA waste-regulated solvents with rad components	Fuel recycling at Diversified Scientific Services, Inc. (DSSI)-permitted boiler	\$19,815 – 52,840/ m <sup>3</sup> Actual costs depend on levels of radionuclides, metal content, % water, and halogen content	\$5000 per shipment
Activated RCRA waste components	Macroencapsulation	\$15,000/ m <sup>3</sup>	\$5000 per shipment
Fluorescent tubes with mercury	Amalgamation followed by landfill	\$105,900/ m <sup>3</sup>	\$5000 per shipment
Printed circuit boards	Macroencapsulation	\$15,000/ m <sup>3</sup>	\$5000 per shipment

## 6.4 Issues

**Issue 1: Waste without a Disposal Path.** Several forms of MLLW cannot be disposed of because no vendors will accept that material. The Laboratory has very few MLLW treatment systems as these are very expensive to permit (about \$100,000 per treatment process). Consequently, several Laboratory wastes must be stored, awaiting a disposal option. For waste that cannot be disposed of, DOE Albuquerque Operations Office (AL) has established a special procedure for obtaining approval to produce it. Examples of such waste include most mercury-contaminated radiological materials and RCRA waste combined with TRU isotopes having a specific activity >10 nCi/g.

**Issue 2: Listed Wastes.** In several cases, the Laboratory uses solvents (toluene and methylene chloride) in very small quantities, which once they become waste, are RCRA-listed wastes because of their toxicity. Because these are listed wastes, it does not matter how little appears in the waste stream, the stream is still a listed waste (presuming it also has a radiological component). *De minimus* thresholds for some listed wastes would reduce the quantities of MLLW generated at the Laboratory. The EPA is proposing new rules for small quantities of these chemicals that would give the Laboratory more flexibility in minimizing them.

**Issue 3: Below-Background Radiological Contamination.** Every waste item leaving an RCA is assumed to be radiologically contaminated unless there is acceptable proof that the item has remained contamination free ( i.e., acceptable knowledge that the item was never exposed to radiological material), and/or it can be surveyed and declared nonradiological according to the criteria established in DOE Order 5400.5. The specified criterion, however, applies only to surface-contaminated objects. There are no criteria specified for porous or activated objects that may be volume contaminated (e.g., wood planks). In addition, many surface-contaminated objects cannot be surveyed, due to surfaces that are inaccessible to the available survey instrumentation, and must be treated as volume contaminated items.

The ANSI has passed a new standard (ANSI N13.12) that establishes limits for releasing potentially volume-contaminated items leaving RCAs. DOE acceptance of this standard would enable more accurate waste segregation and avoid generation of MLLW with near-zero radiological contamination.

**Issue 4: Radiological Characterization Uncertainty.** A significant fraction of designated MTRU waste is actually MLLW. Because of radiological characterization uncertainty resulting from radiation background where characterization occurs and from the capability of the instruments used, however, it is not possible to distinguish MTRU waste from MLLW when the specific activity exceeds 10nCi/g. To avoid adverse findings from a misclassification of waste, most waste >10 nCi/g is classified as MTRU. Before being shipped to WIPP, however, all MTRU waste will be assayed accurately for specific activity. At that time, misclassified MTRU waste will become MLLW and will be disposed of as such. To avoid the expense of this extra characterization, Laboratory facilities must perform more accurate radiological assays.

**Issue 5: Control of Materials Which Will Be RCRA Waste at Disposal.** There is limited guidance for minimizing hazardous materials brought into RCAs, which will be RCRA waste once discarded.

## 6.5 MLLW Waste Stream Description

MLW waste streams arise from processes at various Laboratory sites and in some cases are interrelated to other waste streams. For example, MLLW in the category “other” comes from decontamination processes. Because this stream is captured in other process maps, it is not called out explicitly with a map of its own. Similarly, contaminated PPE and contaminated equipment are generated in many processes. These streams are also captured in other process maps. For the smaller waste streams, process maps have not been developed. Presented after the MLLW waste streams listed and defined below, is Figure 6.5, depicting the percentage that each contributes to Laboratory MLLW.

- **Spills (18.6 m<sup>3</sup>):** Spills occur randomly across the Laboratory; no single RCA or group dominates this waste stream. Spill waste includes the spilled material, spent-spill cleanup kit, containment barriers, and PPE worn during spill cleanup.
- **Debris (5.0 m<sup>3</sup>):** Debris is contaminated copper pipe with lead solder joints, contaminated plastic sheets, duct tape, hoses, and used pump housings.

- **Gloveboxes (4.6 m<sup>3</sup>):** Gloveboxes are mixed waste because they are internally contaminated with hazardous constituents and radioisotopes or they have lead shielding welded into their walls.
- **PPE (4.6 m<sup>3</sup>):** Personnel protective equipment (clothing) is used to process mixed low-level materials and is disposed of as MLLW. It is normally incinerated by an offsite vendor.
- **R&D Chemicals (3.5 m<sup>3</sup>):** Spent chemicals from research projects and production operations are generated in milliliter to several-liter quantities and are consolidated into 30-gal. volumes before being sent offsite for disposal (typically incineration).
- **Lead (1.3 m<sup>3</sup>):** This waste stream comprises activated or surface-contaminated lead shielding, contaminated lead paint, and lead components. Lead normally is sent to Envirocare, Inc. for encapsulation and land disposal, although surface-contaminated lead parts are decontaminated and recycled.
- **Circuit Boards (1.0 m<sup>3</sup>):** Circuit boards from electrical equipment contain lead solder. If contaminated with radioactive materials, they are disposed of as MLLW.
- **Fluorescent Tubes (3.4 m<sup>3</sup>):** Tubes that become activated in an RCA must be disposed of as MLLW. This typically occurs only at LANSCE (in the Proton Storage Ring). (This stream was eliminated in FY 98)
- **Other (3.6 m<sup>3</sup>):** This consists of decontaminated water, decontaminated fluids, and miscellaneous other materials.

#### Mixed Low-Level Waste Stream

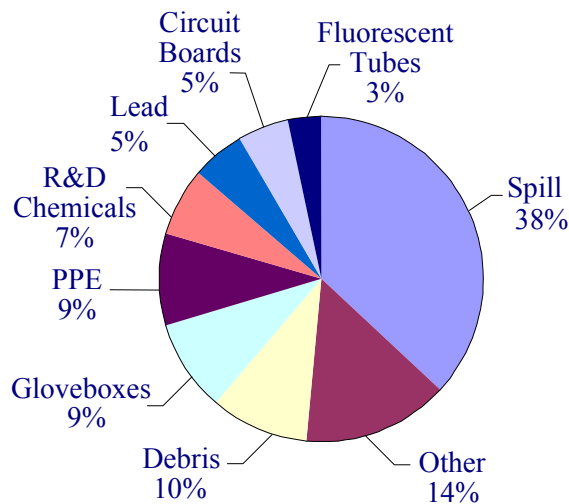


Figure 6-5. Mixed low-level waste stream generation down trend.

## A. Spills

From an operational perspective, spills can be divided into two categories: (1) accidental spills, such as a containment failure or a dropped bottle of chemicals; and (2) leaks, where water or a hazardous chemical may leak from a storage vessel or system into a containment area. Limiting the number and severity of accidental spills is being addressed by the safe work practices and hazard control plans, which are elements of ISM. The consequences of spills can be reduced by further substitution of nonhazardous materials for hazardous materials, improvement of secondary containment for certain processes, and treatment to remove metals from aqueous spills.

Spills generate more than one third of the total annual MLLW at the Laboratory. Typical spills include broken mercury thermometers, broken lamps or blown mercury lamps, and water spills that enter contaminated areas or sumps. The process map for spills and identified options are shown in Figure 6-6. Programmatic mission needs define the work that must be accomplished in an RCA.

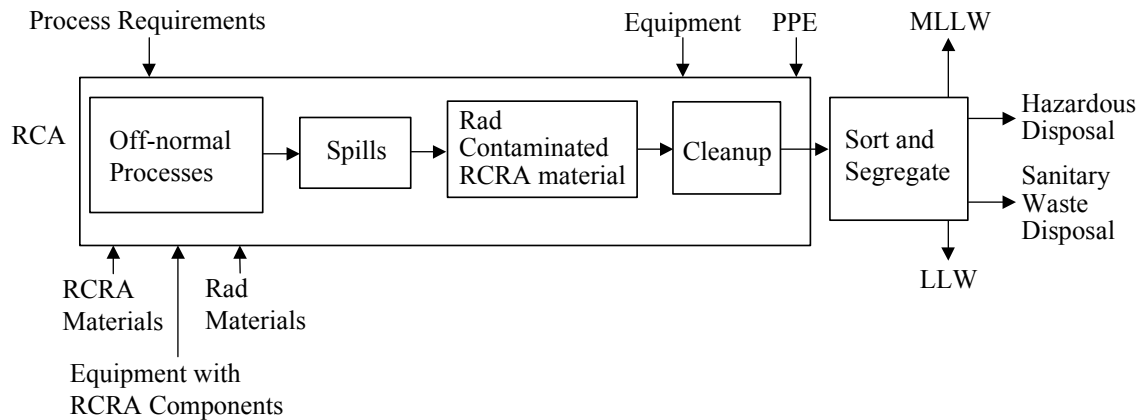


Figure 6-6. Process map for spills.

To accomplish programmatic work, an RCA facility is configured and outfitted to accommodate processes involving radioisotopes and hazardous chemicals. Many of the Laboratory's RCAs process TRU waste materials (plutonium, americium, etc.). Because these materials are very difficult to detect and because the DOE has a no-rad-added policy, any RCRA spill debris leaving a TRU waste RCA is assumed to be MLLW. (The no-rad-added policy states that whenever DOE mission activities could have added non-natural radioactivity to a material, that material shall be treated as radiologically contaminated. This policy was modified recently by DOE Order 5400.5, which set free-release limits for certain nonporous materials that are only surface contaminated.) Once a spill occurs, it is cleaned up using the appropriate spill cleanup kit and procedure. The spilled material, the cleanup materials, the PPE worn by the cleanup team, and the material used to cordon off the spill area are all disposed of as MLLW.

## B. Gloveboxes

Many gloveboxes are lined with high-atomic-number material (such as lead) to protect workers from radiation exposure. Once such gloveboxes are radiologically contaminated, they become mixed waste, even though the lead is welded into the glovebox walls and is not in contact with radioisotopes. In a few cases, the interior of a glovebox also is contaminated with hazardous materials, but in most cases, this contaminant can be removed. The process flow map for gloveboxes is shown in Figure 6-7.

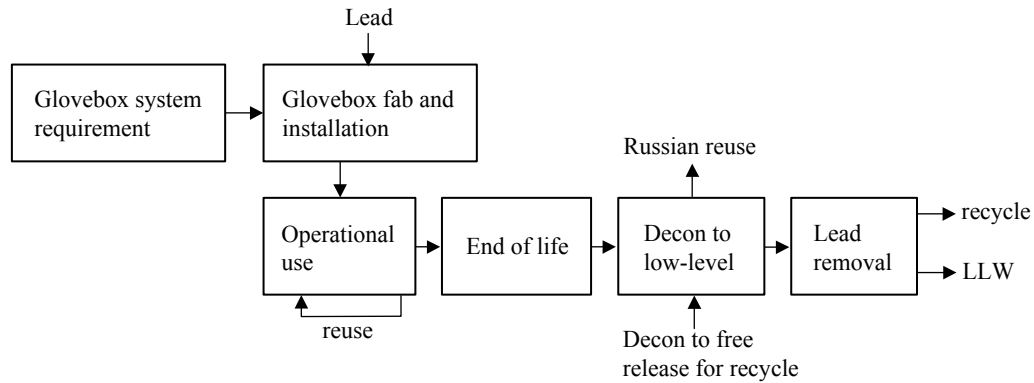


Figure 6-7. Process map for gloveboxes.

A mission program requires that certain work be accomplished only in a glovebox. Shielding is necessary to minimize the radiation dose to workers. Glovebox design standards require that the shielding be lead and that it be welded into the front glovebox wall. Shielding is welded in, rather than hung from the front of the box to minimize and smooth the outer surface of the box. If the outside becomes contaminated, only a minimal smooth surface needs to be decontaminated. Lead was chosen as the shielding material because of its formability, shielding properties, and low cost.(See Figure 6-8).

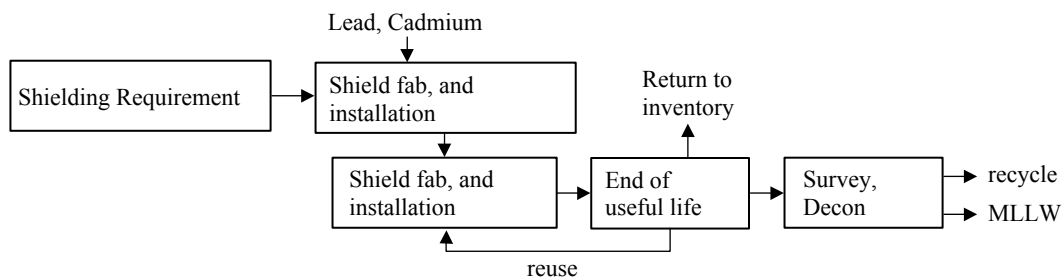


Figure 6-8. Process map for shields.

Next, the glovebox is fabricated, installed, and used. Either the glovebox will become “worn out” or mission programmatic needs will change, and the space that the glovebox occupies will be needed for another process. Most often, the new process requires a new glovebox. If the spent glovebox becomes sufficiently worn out that it is unsafe to work in, it will be disposed of as MTRU waste. Worn-out gloveboxes are decontaminated electrolytically (either in TA-55, CMR, or TA-50); the lead then is removed by breaking the stainless steel welds (at TA-50 facility). The lead is surveyed, free-released under DOE Order 5400.5, and recycled through a commercial vendor. Gloveboxes that are not worn out and fit a LANL requirement or that of another organization, are diverted for reuse after they have been decontaminated. Reuse can be either in a LANL facility or in Russia or Kazakhstan, at a facility conducting joint research under DOE sponsorship. (See the TRU waste and LLW sections for a more detailed discussion of glovebox waste minimization.)

### C. Research Chemicals

The process map for research chemicals is shown in Figure 6-9. A wide range of hazardous chemicals is stored in RCAs. The chemicals are mixed with radiological materials to meet mission work requirements. Spent chemical solutions and the equipment that contained them are potentially MLLW. Sometimes the equipment is not MLLW because of the RCRA waste “empty-container” rule. In that case, the equipment can be disposed of as LLW. If the RCRA waste component cannot be eliminated by the waste generator or by electrochemical processing, the spent solution is designated as MLLW and sent through satellite and less-than-90-day storage areas to SWO, Area L, TA-54. MLLW chemicals are bulked at Area L and sent to Diversified Scientific Services (DSSI).

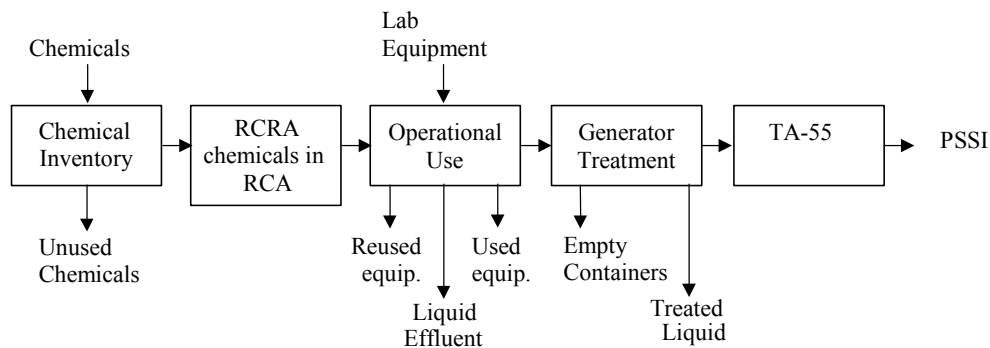


Figure 6-9. Process map for research chemicals.

### D. Electronics

Because most electronics have printed circuits that contain lead, those electronics become MLLW if they become contaminated with radiological materials. In almost all cases, it is extremely unlikely that the electronics will be exposed to radiological contamination. However, in most cases, there is no acceptable proof that the electronics were never

contaminated. For beta- and gamma-emitting radioisotopes, contamination is easy to detect using standard radiological assay instruments. However, for alpha-emitting isotopes, it is very expensive to measure the activity of every surface on a circuit board. In addition, disassembly and measurement typically destroy the equipment. Today, most electronics are disassembled and their circuit boards are surveyed and then sent to a commercial recycler. MLLW circuit boards are sent to Envirocare where they are encapsulated in plastic and buried in an LLW landfill. The process map for the electronics waste stream is shown in Figure 6-10.

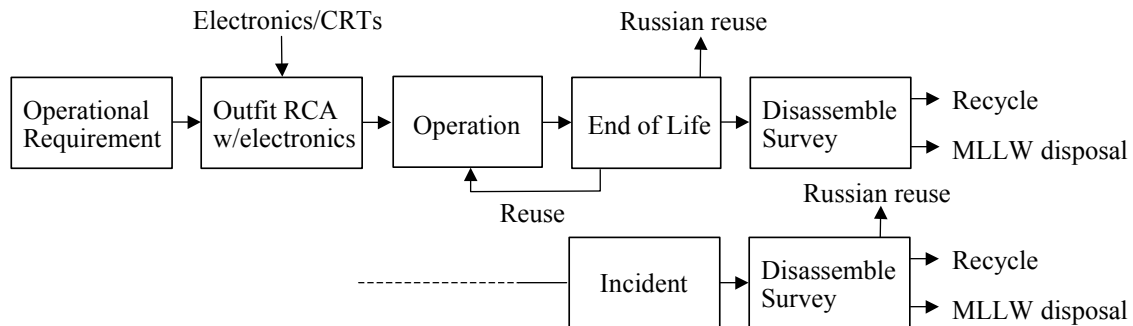


Figure 6-10. Process map for electronics.

## 6.6 Initiatives

For the MLLW streams, the Laboratory is pursuing initiatives and action plans with milestones, concentrating on developing processes and programs for advancing the MLLW program goal of reducing the volume of Laboratory MLLW that requires disposal. The MLLW Stream Goal is presented at the beginning of Section 6.0 in Figure 6-2.

The following waste reduction initiatives have been identified for the MLLW streams and are briefly described below. Action plans to support each initiative, with additional information on milestones, status, and avoidance information is presented in Appendix 1C.

### **Initiative M-1: Improve Characterization Processes and Techniques**

- Develop protocols for more accurate determination of hazardous materials.**  
 The present EPA standard of Toxic Characteristic Leaching Procedure (TCLP) determination may not reflect the actual leachability of RCRA metals. Furthermore, low concentrations of chemicals may not meet the definitions of other RCRA waste forms, such as reactivity.

### **Initiative M-2: Improve Acceptable Knowledge (AK) Use and Documentation**

- **Simplify the characterization process.** Use AK to decrease equipment and material being disposed of as contaminated. Improve the AK on equipment that is inside an RCA for extended periods of time to determine whether the equipment can be reused or recycled.
- **Monitor Equipment in RCAs.** Placing some type of monitoring device inside each piece of equipment may make it possible to easily determine whether the equipment is internally contaminated and whether it can be reused or recycled.

### **Initiative M-3: RCA Source Reduction**

- **Minimize the amount of hazardous material entering RCAs.** Because the majority of hazardous materials entering RCAs are critical to programmatic activities, it is difficult to utilize source-reduction techniques. However, the exact amount of material entering an RCA can be minimized by specifying exact quantities before transferring them into an RCA.
- **Further Reduce RCA Size.** This is a follow-on to an FY96–97 radioactive waste minimization project. Implementation details are being developed. This initiative overlaps with LLW reduction options.
- **Materials Substitution.** By analyzing the organic components of MLLW, it is possible to determine which organic chemicals are responsible for mixed waste. The processes whereby these chemicals are mixed with radioisotopes can be analyzed, and nonhazardous chemicals can be substituted.
- **Microchemistry.** Many analytic chemistry and chemical research processes that generate MLLW use significantly more chemicals than are necessary. In recent years, microchemical procedures that use very small chemical volumes have been developed. The Environmental Stewardship Office has piloted microchemistry operations in NMT-1 with the installation of a solvent extractor. A more complete evaluation of Laboratory chemical practices should identify additional waste minimization opportunities. It is expected that microchemical training will be necessary, in addition to purchasing microchemical instruments.
- **Nonhazardous, Low-Mercury Fluorescent Bulbs in All RCAs.** Broken fluorescent tubes are treated as mercury spills. Replacement of current hazardous bulbs with nonhazardous bulbs would eliminate this waste stream. This replacement could occur as current bulbs are replaced at the end of their typical lifetime, which is 3 years. There would be no additional cost, and annual waste avoidance would equal 0.1 m<sup>3</sup>/year. Implementation of this option requires a site-wide prohibition on the use of hazardous fluorescent bulbs. These bulbs have been prohibited since FY'98.

- **Mercury Thermometer and Manometer Replacement.** Replacement mercury thermometers in RCAs with digital or alcohol-based thermometers would eliminate this waste stream. Note: Many mercury-contaminated radiological wastes cannot be disposed of commercially and currently are stored at TA-54. The Waste Management Program is funding development of a water-soluble polymer treatment to remove mercury from these wastes.

#### **Initiative M-4: Glovebox Useable-Life Extension**

- **Design Gloveboxes for Longer Life.** Longer glovebox life has two components: (1) standardizing the box design so that new processes routinely can be moved into used gloveboxes, and (2) enhancing protection of the glovebox interior surfaces so that they do not become contaminated by hazardous materials and are more resistant to corrosives used in the glovebox.

#### **Initiative M-5: Lead/Cadmium Issues:**

- **Substitute Nonhazardous Material for Lead Shielding in Gloveboxes.** Although lead has good shielding/price/workability properties, gloveboxes could be manufactured with stainless steel walls that are two and a half times thicker and achieve the same radiation shielding performance. This likely would cost less than the current practice of welding a stainless steel sandwich around lead. Lawrence Livermore National Laboratory (LLNL) gloveboxes are fabricated with such a thick stainless steel wall. Another option is to replace lead with tungsten beads or a tungsten-powder-loaded thermal-set polymer. Personnel safety, radiation exposure, and impact on the ease of work in the glovebox must be investigated.
- **Substitute Nonhazardous Material for Lead Shielding in other applications.** Glove liners, areas with frequent contamination releases, and unusual shapes that cannot be grit blasted may substitute rare earth oxide powders for lead or cadmium. Another option is to replace lead with tungsten beads or tungsten-powder-loaded thermal-set polymer in these applications.
- **Optimal Shielding Designs.** Many shielding systems are not based on scientific designs but rather on operating experience. Operating experience tends to stack the maximum amount of lead into the available space and then measure to confirm that the shielding is sufficient. For shields requiring more than some threshold weight of lead, a science-based shielding design could be required. This would enable the use of a reduced but effective amount of lead.
- **Lead Encasements in Gloveboxes.** Develop a facility with the capability to remove lead from gloveboxes by breaking the stainless steel weld at the TA-50, Decontamination Facility.

#### **Initiative M-6: Contamination Avoidance**

- **Protective Coatings.** Lead and cadmium are the primary metals used for radiation shielding in RCAs. Several commercial coatings are available to protect such metals from radiological contamination. Coatings can be removed from the lead as it leaves the RCA; the lead can be recycled and the coating disposed of as LLW or MLLW.
- **Chemical Management System Use.** This system would ensure that only the necessary chemicals, with no duplication, are brought into an RCA and that all is evaluated properly to determine what methods could be used to prevent mixed waste contamination. Such a system would also control, inventory, and label all hazardous materials in RCAs. This concept is being developed, and overlaps with hazardous waste minimization options.

- **Replace CRTs with Flat Panel Screens.** Such a replacement would eliminate the hazardous materials that are associated with cathode ray tubes (CRTs). This substitution would also avoid the possibility of internal contamination of CRT screens.

#### **Initiative M-7: Oil-Free Pumps**

- **Oil-Free Pumps in RCAs.** Vacuum pumps that support radioisotope processing and analysis can become contaminated. This can result in MLLW pump oil if the oil includes RCRA constituents or if these wastes have accumulated in the oil during operation. Converting to oil-free pumps would eliminate the source of this waste. Oil-free pumps come in two varieties: those that use no oil and those that use oil to lubricate bearings. An evaluation of RCA vacuum-pumping needs and available pump technology will determine which oil-based pumps can be eliminated. Based on the results, a policy can be developed to preclude the use of oil-based vacuum pumps in RCAs.

#### **Initiative M-8: Central Facility for Characterization, Sorting, Segregation, and Decontaminate**

- **Characterize, sort, segregate, and decontaminate lead.** To assist waste generators and encourage recycling, a centralized facility has been established at the TA-50 Decontamination Operation. This activity is essential to minimize MLLW disposal. An extensive program to encourage the characterization, sorting, segregation, and recycling of lead at the Laboratory has been in place for several years, with a total of 4.0 m<sup>3</sup> of lead being recycled by the end of FY99.
- **Develop improved characterization techniques to increase the amount of material that can be recycled.** TRU radioisotope contamination is very difficult to detect because of the small range of alpha particles in the air. New characterization techniques are needed to enhance the ability to detect alpha particles so that the amount of equipment that can be reused or recycled can be increased.

#### **Initiative M-9: Equipment Reuse and Exchange Program**

- **Lab-wide RCA Electronics Reuse System.** Once property-numbered equipment enters an RCA, it is marked as having been disposed in the Laboratory property inventory system. In most cases, when this equipment is no longer needed in the RCA, it still has considerable useful life. Under this reuse system, the Laboratory will establish a web-based database of equipment excessed from RCAs. Projects in other RCAs will be able to reuse this equipment. A web page listing excess RCA electronics and other equipment will be established. The fraction of equipment reused will be measured to determine the waste avoided.

- **Russian Reuse of Gloveboxes.** LANL will spend almost one billion dollars over the next 10 years upgrading radiological facilities to accomplish the Laboratory stockpile stewardship and management missions. The glovebox systems in several facilities will be replaced. The excessed systems would have to be disposed of as MLLW, however, to avoid this waste generation, LANL has negotiated agreements with the International Science and Technology Center to transfer this equipment to Russian and Kazakhstani laboratories which operate radiological facilities and can use this equipment.

A pilot shipment of three SeaLand containers of excess gloveboxes has been sent to Mayak in FY99 at a cost of \$10,000 per SeaLand container. WM Upstream Treatment Project will fund this effort in FY99 and beyond. The waste avoided is 30 m<sup>3</sup> of MLLW with a return on investment (ROI) of 330%, calculated by assuming that the gloveboxes would otherwise be disposed of as MLLW. This initiative is related to the MLLW initiative to reuse electronics (containing lead circuit boards) and a LLW initiative to reuse excess equipment from RCAs.

- **Russian/Kazakhstani Reuse of RCA Electronics.** Similar to the system described for gloveboxes, excess electronics for which there is no onsite reuse will be transferred to Russian and Kazakhstani research facilities performing DOE-sponsored work at a cost of \$60,000 for shipping. The funding source is the WM Upstream Treatment Project. The waste avoided is 120 m<sup>3</sup>/year with an ROI of 20,000%. (Note that the ROI is based on disposing of entire electronic instruments as MLLW—it is more likely that this equipment would be disassembled and surveyed and the circuit boards recycled at a lesser cost.)

#### **Initiative M-10: MLLW Avoidance through Treatment**

- **Neutralize Acids and Bases to Remove Liquid from the Mixed Waste Stream.** By adjusting the pH of acidic and basic liquids mixed with radionuclides, it is possible to remove these items from the MLLW stream and convert them to the LLW stream. This will lower the disposal cost of these waste sources significantly.
- **Hydrothermal Processing.** See the discussion in the 4.0 TRU Waste section.
- **PMR for Liquid Tritiated Wastes.** Tritium research and operations generate a small volume of tritium-contaminated organic solvents. The organic component can be oxidized and the tritium recovered using the Palladium Membrane Reactor (PMR) system. The PMR combines hot carbon monoxide with the organic solvent in the presence of a palladium membrane. As do all hydrogen isotopes, the liberated tritium permeates the membrane and is separated by cryogenic fractionation. Note that this same system can be used to recover tritium from tritiated process water.

### **Initiative M-11: Mediated Electrochemical Oxidation**

- Mediated Electrochemical Oxidation.** Each year, analytic chemistry activities produce several thousand small containers of organic solvents and radioactive metals in solution. Toluene, methanol, and methylene chloride are the primary solvents. These are disposed of as MLLW and cost \$200,000 to \$500,000/m<sup>3</sup>. The high costs result from the need to characterize and bulk these chemicals into 30-gallon drums and the high cost of disposal. Mediated electrochemical oxidation's (MEO's) effectiveness has been demonstrated at LLNL and Pacific Northwest National Laboratory (PNNL). MEO is used in a production mode by the French nuclear industry to recover radioisotopes from a wide range of spent materials. An MEO system includes an electrochemical cell with nitric acid electrolyte solution, a mediating metal (at LANL, cerium), and a plutonium-organic solvent feed material. (Other feed materials are possible as well, e.g., finger cartridge filters, contaminated vacuum pump oil, contaminated cheese cloth, etc.). The electrocell doubly reduces the cerium: the electrocell oxidizes the organic solvent, and the plutonium dissolves into the nitric acid solution. After all of the organic solvent has been oxidized to nonhazardous materials, the plutonium-nitric acid solution is removed. The plutonium will be reclaimed and the nitric acid neutralized, dried, and disposed of as LLW. Note: This waste stream may be considered a listed waste under RCRA. If the waste is listed there is no benefit to processing the waste.

A pilot MEO system was installed at CMR. Testing was successful. However, full scale implementation of the process has been placed on hold because it is still more cost effective to send the waste to a commercial treatment facility.

### **Initiative M-12: Procedure Changes**

- Improve or develop procedures to encompass waste minimization techniques and improved characterization.** Develop comprehensive pollution prevention and waste minimization support documentation as new procedures or as improvements to existing documentation and programs, e.g., waste handling procedures and the Generator Waste Certification Program (GWCP).

### **Initiative M-13: Training Improvements**

- Develop training to be required for the Generator Waste Certification Program (GWCP).** Develop comprehensive pollution prevention and waste minimization training for quarterly presentation. Require successful completion of training for WMCs, as a minimum, and consider requiring it for waste generators and adding it to the technical evaluation standards for waste handlers/technicians. Require Green Zia analysis as part of the GWCP certification process.
- Improve or develop training.** Modify all waste handling training to encompass waste minimization and improved characterization techniques.

**Initiative M-14: Cultural Changes**

- **Support Laboratory-wide cultural change.** There are many underlying attitude and global changes that need to be developed at the Laboratory to best support the commitment to pollution prevention and waste minimization. There needs to be a Lab-wide commitment to Laboratory Implementation Requirements and a commitment to making waste minimization, characterization, sorting, segregation, and decontamination inherent in daily work. All personnel need to automatically include the waste minimization hierarchy in Step One of the 5-Step Process and to integrate it into all other Steps. Solid integration of waste minimization, characterization, sorting, segregation, and decontamination into all work control processes at all Lab-wide facilities is needed. This would require adoption of these concepts into the very culture of the Laboratory.

## 7.0 HAZARDOUS WASTE

### 7.1 Summary

The Resource Conservation and Recovery Act and 40 CFR 261.3, as adopted by the New Mexico Environment Department, define hazardous waste as any solid waste that:

1. is generally hazardous, if not specifically excluded from regulation as a hazardous waste;
2. is listed in the regulations as a hazardous waste;
3. exhibits any of the defined characteristics of hazardous waste (i.e., ignitability, corrosivity, reactivity, or toxicity); or
4. is a mixture of solid and hazardous waste.

The Laboratory produces routine and nonroutine hazardous waste as a by-product of mission operations. “Routine waste” is waste from daily, ongoing operations at the laboratory. “Non-routine waste” is waste from legacy operations or environmental restoration. See Figure 7-1 for trends in generation.

Hazardous waste also includes substances regulated under the Toxic Substances Control Act, (TSCA) such as polychlorinated biphenyls (PCBs) and asbestos. Finally, a material is hazardous if it is regulated as a Special Waste by the State of New Mexico as required by the New Mexico Solid Waste Act of 1990 (State of New Mexico, 1990) and defined by the most recent New Mexico Solid Waste Management Regulations, 20NMAC 9.1 (NMED, 1994) or current revisions. This includes the following types of solid wastes that have unique handling, transportation, or disposal requirements to assure protection of the environment and the public health, welfare, and safety:

- Treated formerly characteristic hazardous (TFCH) wastes;
- Packing house and killing plant offal;
- Asbestos waste;
- Ash;
- Infectious waste;
- Sludge, except compost which meets the provisions of 40 CFR 503;
- Industrial solid waste;
- Spill of a chemical substance or commercial product;
- Dry chemicals, which, when wetted, become characteristically hazardous; and
- Petroleum-contaminated soils.

Hazardous wastes are disposed of through two Laboratory subcontractors: Safety-Kleen, Inc. and Chemical Waste Management, Inc. They send waste to permitted Treatment, Storage or Disposal Facilities (TSDFs), recyclers, energy recovery facilities for fuel blending or burning for BTU recovery, or other licensed vendors (as in the case of mercury recovery). The treatment and disposal fees are charged back to the Laboratory at commercial rates specific to the treatment and disposal circumstance. The actual cost varies with the circumstances; however, the average cost for onsite waste handling by SWO and offsite disposal is \$11.75/kg.

## 7.2 Hazardous Waste Minimization Performance

DOE has implemented goals for waste minimization. Goals for FY99 were for DOE to achieve a 50% reduction in routine hazardous waste generation. Figure 7-1 shows Los Alamos National Laboratory's success in achieving this goal.

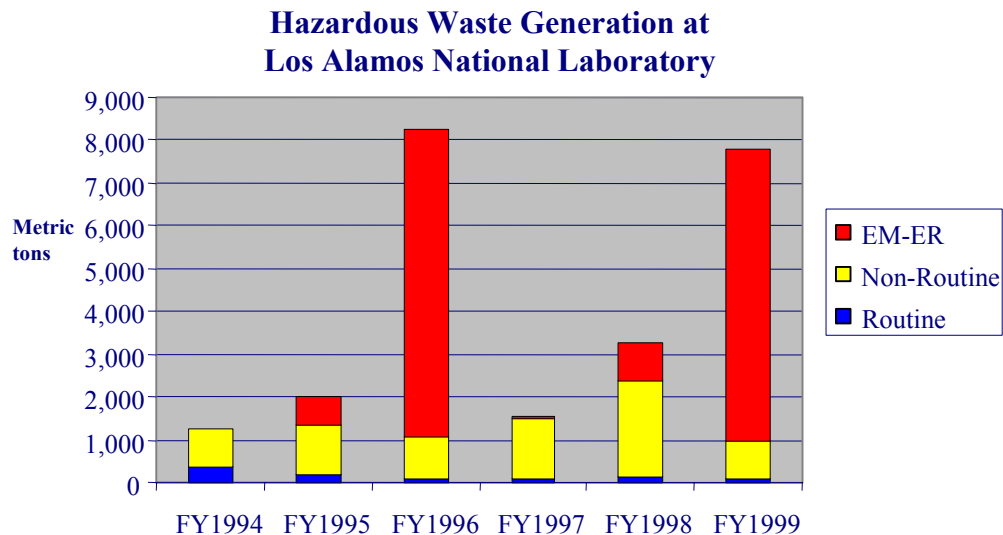


Figure 7-1. Total hazardous waste generation at LANL: FY 1994 to FY 1999.

For FY 2005, DOE will strive to minimize waste and the Department's environmental leadership program will go beyond compliance requirements to be based on continuous and cost-effective improvements. To achieve these goals, the Laboratory must use pollution prevention processes that lead to minimal waste generation and lowest possible life-cycle costs.

The hazardous waste goal for 2005 is to reduce waste from routine operations by 90% by 2005, using a 1993 calendar year as the baseline. The following graph, Figure 7.2, depicts this trend.

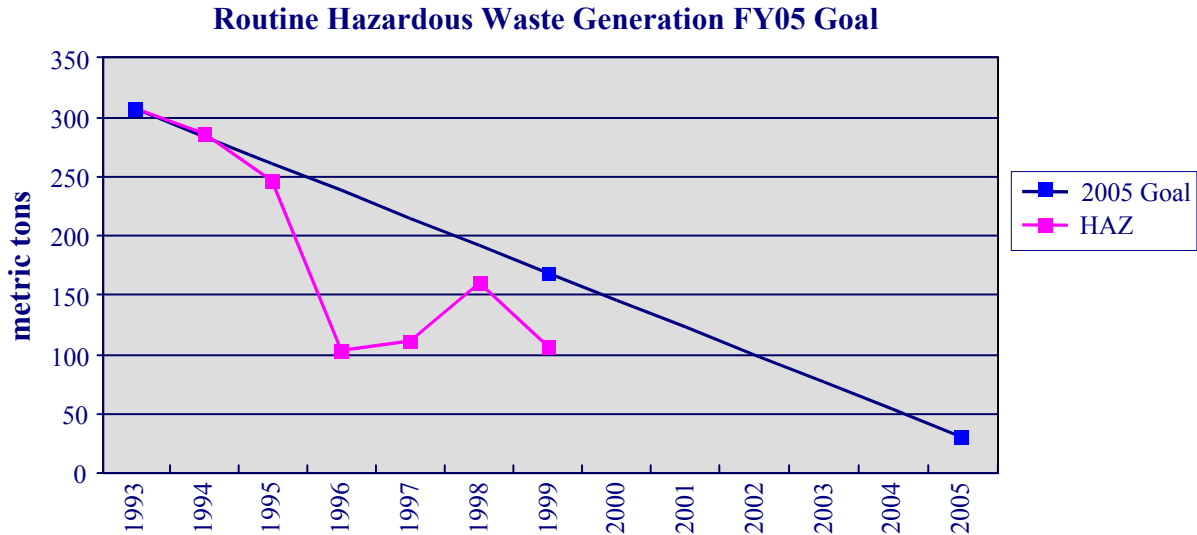


Figure 7-2. Routine hazardous waste generation: FY 1999 and FY 2005 goals.

### 7.3 Hazardous Waste System Description

Most Laboratory activities generate some amount of hazardous waste. Hazardous waste commonly generated at the Laboratory includes many types of laboratory research chemicals, solvents, acids, bases, carcinogens, compressed gases, metals, and other solid waste contaminated with hazardous waste. This may include equipment, containers, structures, and other items intended for disposal and contaminated with hazardous waste (e.g., compressed gas cylinders).

Various hazardous materials are already in the Laboratory's material inventory or are brought in as part of Laboratory operations. These substances are used in performing work and are collected when they are depleted or no longer needed. After being collected, they are sorted and segregated. Some materials are reused within the Laboratory, and others are decontaminated for reuse. Those materials that cannot be decontaminated or recycled are sent off site for disposal. The Laboratory will spend a total of \$6,500,000 managing newly-generated hazardous waste in FY00.

Over FY97, FY98 and FY99, the hazardous waste volume has been dominated by nonroutine waste. In addition to categorizing waste as routine and nonroutine, hazardous waste also is tracked according to the way it is regulated, i.e., RCRA, New Mexico Special Waste, or TSCA waste. The relative magnitude of the waste types is shown in Figure 7-3 for hazardous waste generation with exclusions noted.

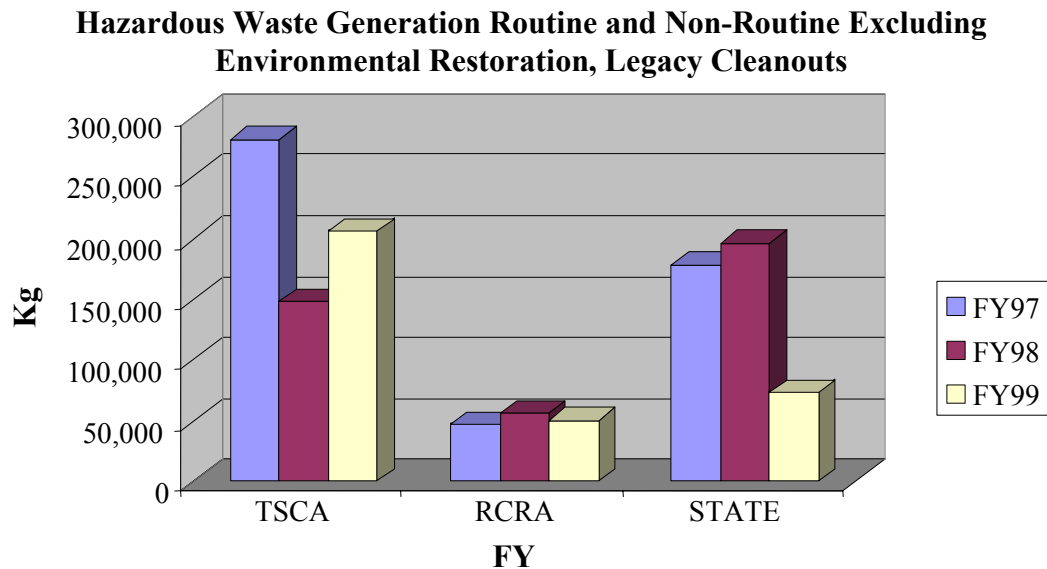


Figure 7-3. Hazardous waste generation by TSCA, RCRA and State Special wastes.

The top-level process map for hazardous waste is shown in Figure 7-4 below. Upon generation, hazardous waste typically is transferred to a satellite, universal waste, or 90-day storage area. Otherwise, upon receipt of proper waste and Department of Transportation documentation, hazardous waste is transferred to Solid Waste Operations (SWO), at Area L, TA-54 for storage, bulking, and transportation. From Area L, it is sent to commercial disposal facilities.

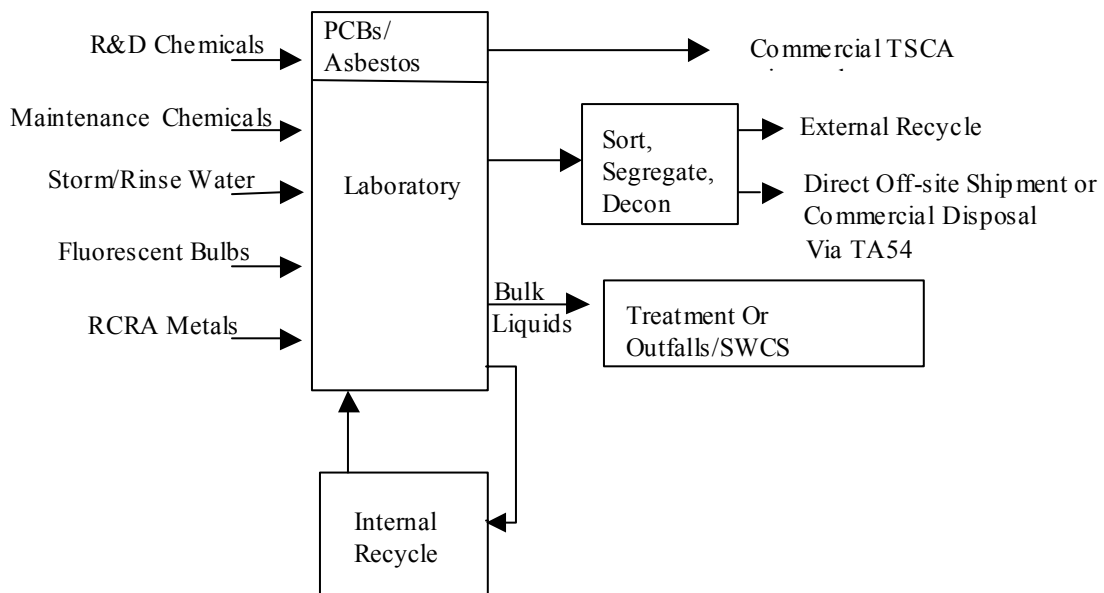
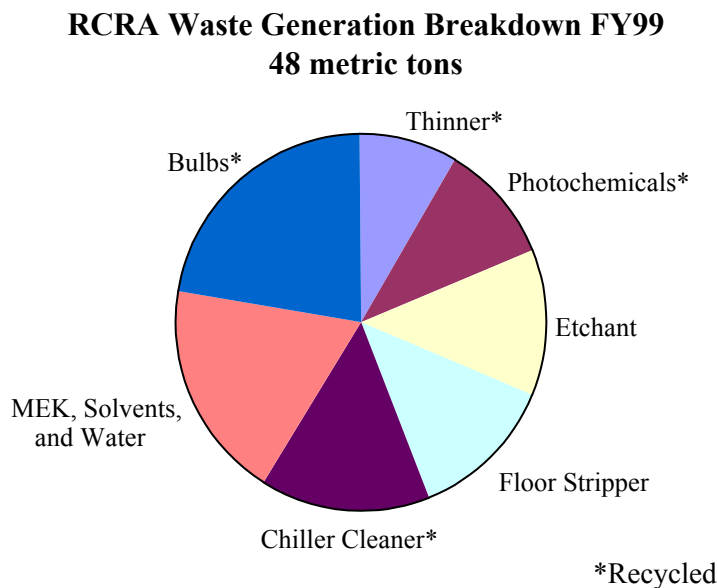


Figure 7-4. Hazardous waste process map.

### A. RCRA Waste Breakdown

Approximately 48 metric tons of RCRA waste was generated in FY99, excluding Environmental Restoration waste. Approximately 6.8 metric tons of this waste stream was recycled. The pie chart in Figure 7-5 represents a breakdown of this waste stream. The waste streams will be described following the figure. The asterisked items on this and subsequent charts denote materials that are carried as waste in the databases but in fact are recycled.



\*Materials that are carried as waste in the databases but which, in fact, are recycled.

Figure 7-5. RCRA waste generation breakdown for FY99.

- Fluorescent Bulbs\* (9.3 MT FY99):** Fluorescent bulbs are used across the Laboratory complex. JCNM performs most bulb changeouts. The bulbs are recycled for metal recovery. During FY98, the laboratory implemented a requirement to purchase only non hazardous bulbs. Therefore, this waste stream is decreasing.
- Methyl Ethyl Ketones (MEK), Solvents, and RCRA-Contaminated Waters (7.7 MT):** Various rinse waters are contaminated with RCRA constituents. A variety of RCRA components in dilute solutions also are used at the Laboratory. Most of this waste stream comes from explosive experimental production areas at the Laboratory. DX Division produces a variety of rinse waters contaminated with RCRA solvents
- Petroleum and Oils (0.7 MT):** Several Laboratory processes produce RCRA-contaminated petroleum and oil-based wastes. Most often, these petroleum and oil materials are not hazardous. During their use, they are often contaminated with RCRA constituents such as lead or mercury, e.g., vacuum pump oil may become contaminated with lead during use.

- **Chiller Cleaner\* (6.1 MT):** Chiller cleaner is a solution used to remove scaling from heat exchangers. Chiller cleaning usually is performed by Johnson Controls Northern New Mexico (JCNNM). Chiller cleaners are used by LANSCE, CIC, CST, NMT, and other divisions with heat exchangers. The majority of this waste stream is recycled. Chiller cleaner frequently is spilled during cleaning operations, which generates spill-cleanup waste.
- **Floor Stripper ( 5.2 MT):** During FY99, JCNNM disposed of a large quantity of floor stripper that was contaminated with lead based paint. As with petroleum and oils discussed above, the floor stripper itself was not hazardous. When it was used and contaminated with lead, it became a RCRA waste. This was a one-disposal event.
- **Etchant (5.1 MT):** This chemical compound, ferric chloride, is used by the DX Division printed-circuit shop.
- **Photochemicals\* (4.2 MT):** DX and ESA Divisions are the predominate photochemical users. Much of this waste stream is recycled through the TA-50 RLWTF. Technologies such as digital photography, do not meet the specifications needed for photographs by these Divisions.
- **Thinner\* (3.6 MT):** Thinner predominantly is used by JCNNM. A new system was installed in FY98 to recycle spent lacquer thinners. However, the system does not effectively reduce the large volume of this waste stream.

Generation of RCRA waste is broken down by division in Figure 7-6 below.

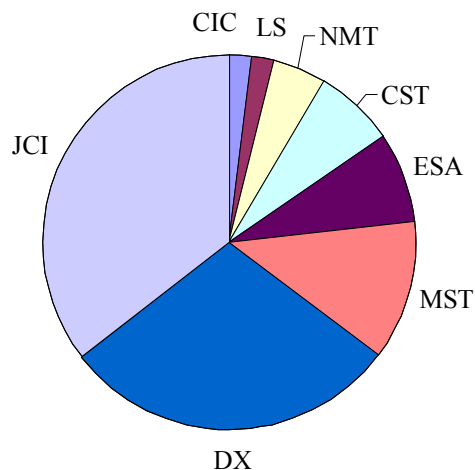


Figure 7-6. RCRA waste generation breakdown for FY99 by division.

## B. State Waste Breakdown

Approximately 627 metric tons of State waste was generated in FY99. However, the majority of this material was from a spill of dielectric oil, which accounted for 565 metric tons of waste. Approximately 36.6 metric tons of this waste stream was recycled. The pie chart in Figure 7-7 depicts the remaining 102 metric ton distribution of this waste type without this large spill, with recycled items asterisked. Eighty percent of the waste stream excluding the large spill will be described below.

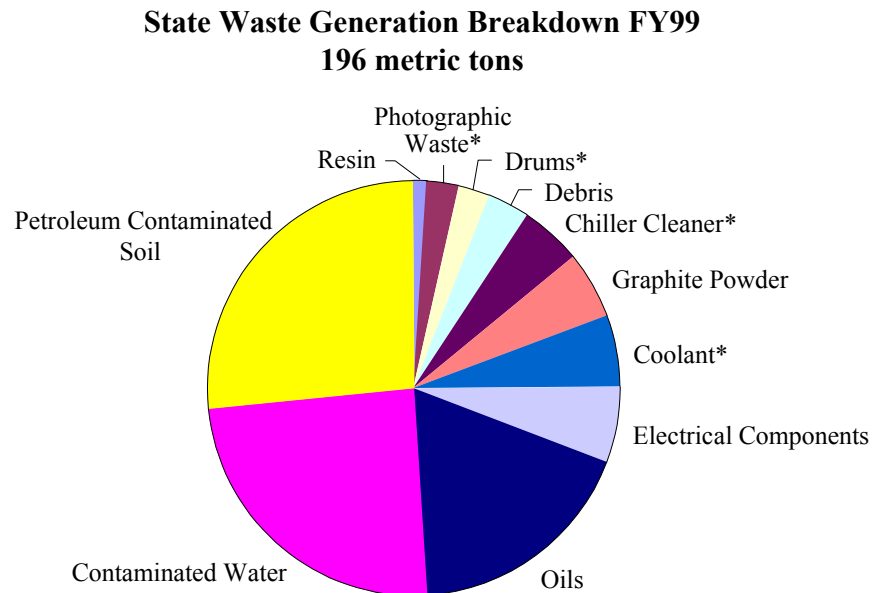


Figure 7-7. State waste generation breakdown by waste stream for FY99.

- Petroleum-Contaminated Soils (565.7 MT):** This waste stream was dominated by spills of petroleum products onto soils. Facilities and Waste Operations (FWO) Division was listed on the Chemical Waste Disposal forms as the main contributor to this waste stream in FY99. Petroleum spills originate with individuals (vehicles), Laboratory organizations, JCNNM, and subcontractors.
- Contaminated Waters (40 MT):** This waste stream includes process and spill waters contaminated with materials such as oils, grease, solids, solutions, ethylene glycol, and antifreeze.
- Burn Ground ( 16.4 MT):** This material is generated by ESA. The group has complete machining capability for most materials and explosives and generates this waste in the process.
- Electrical Components (8.2 MT):** Capacitors, electrical switches, transformers, power supplies, etc., are State waste. In FY98 and FY99, this waste stream was dominated by LANSCE capacitors.

- **Rainwater (5.9 MT):** The sumps from Area L at TA-54 are disposed as state waste.
- **Oils (5.8 MT):** Oils are used throughout the Laboratory, predominately in maintenance operations.

Generation of State Special waste is broken down by division as shown in Figure 7-8.

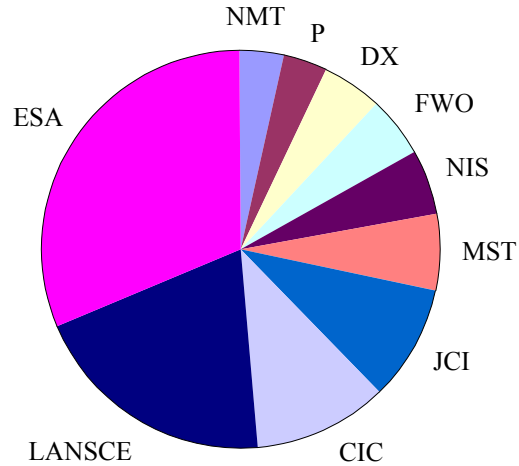


Figure 7-8. State waste generation breakdown for FY99 by division.

### C. TSCA Waste Breakdown

Approximately 175 metric tons of TSCA waste was generated in FY99. The pie chart in Figure 7-9 represents a breakdown of this waste stream. Eighty percent of the waste streams will be described below.

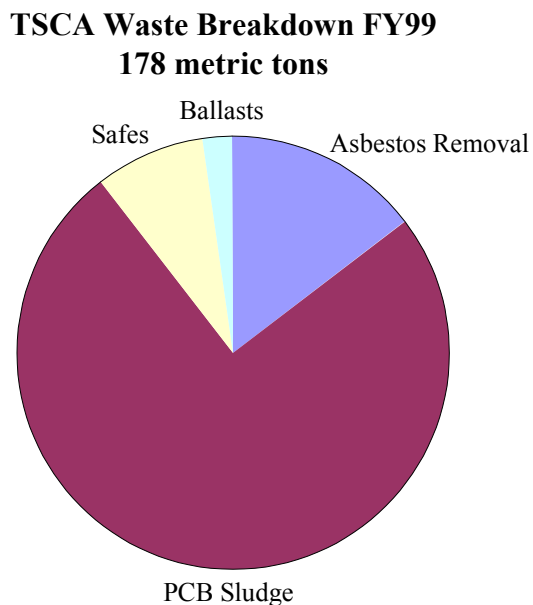


Figure 7-9. TSCA waste generation breakdown for FY99.

- Sewage Sludge (131 MT):** In CY95, LANL grit screenings contained one sample that exceeded the regulatory limit for PCBs. Since then, sanitary sewage sludge has been disposed of as TSCA waste. The largest single constituent of the TSCA hazardous waste type is the PCB-contaminated sanitary sludge. These wastes occur because the sanitary sewer lines upstream of the wastewater plant have PCB contamination. There is also the possibility of PCB contamination from infiltration and inflow of rainwater into buried sewer lines. Surface-water inflow into these contaminated regions serves as a medium for migration of the PCBs. Because the piping is old and undoubtedly breached at many points, the PCB-contaminated water enters the sanitary piping and contaminates the sanitary waste. As a result, the sludge produced by treatment of the sanitary waste is contaminated with PCBs and therefore is TSCA waste. This sludge is sent off site for thermal destruction.
- Asbestos Safes (14.7 MT):** Safes purchased at the Laboratory during the 1940s through the 1970s often contained walls made of asbestos for fireproofing. Asbestos is a regulated TSCA material.
- Asbestos Materials and Removal (25.7 MT):** Various components, such as ballasts, contain asbestos material. There are also a large number of safes at the Laboratory purchased during the 1940s through the 19970s that contain asbestos fireproofing.

Generation of TSCA waste is broken down by division in Figure 7-10.

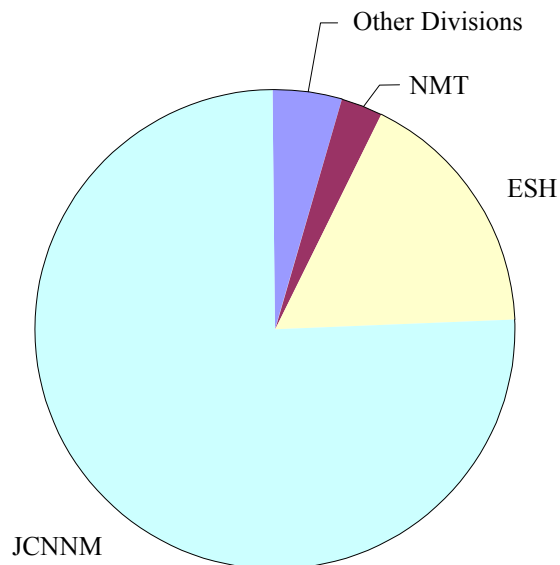


Figure 7-10. TSCA waste generation breakdown for FY99 by division.

#### 7.4. Issues

The following issues affect the hazardous waste stream.

**Issue 1: PCB-Contaminated Sanitary Sludge.** The source of the legacy contamination of PCBs has been identified as a spill in the Sigma Building, the source of the PCB contamination of the grit and screenings at the Solid Waste System Consolidation (SWSC) Plant. These drains were scheduled to be cleaned in FY00, however sampling of the drains led to the discovery of PCB, RCRA metal, and rad contamination of the suspect drains.

**Issue 2: DX Division Wastes.** Alternatives need to be identified for etchant and MEK solutions from this Division. These waste streams constitute a large portion of the Laboratory's RCRA waste stream. This Division is assessing alternatives and solutions through the Green Zia Analyses

**Issue 3: Chemical Tracking.** The current system of managing hazardous waste at the Laboratory is insufficient for tracking the life-cycle from beginning to end. To review the hazardous waste stream adequately for minimization opportunities, safety, compliance with authorization bases, etc., current Laboratory systems must be integrated to track chemicals from their arrival on site through their usage and disposal. The time and effort expended to track this information also must be considered. There are many databases and tracking systems in use at the Laboratory, including Just-In-Time (JIT) purchase records, the [ACIS](#) database, and TA54 records; however, none of these is used specifically for hazardous waste tracking. Some chemicals are bar-coded, whereas others are not if not purchased via the JIT system. ACIS is used by only ~25% of the generators, and most generators keep their own databases to inventory their chemicals. Hazardous waste management and minimization would be facilitated greatly by a beginning-to-end integrated database.

**Issue 4: Unused Chemical Exchange.** The Laboratory does not have an efficient system for chemical exchange, especially for excess chemicals that may be able to satisfy mission needs elsewhere in the Laboratory. A physical chemical exchange system (CHEAPER) was operating a few years ago but was discontinued because of a large buildup of excess chemicals and the cost of maintaining a physical inventory. The chemical tracking system described in Issue 3 above is essential to establishing an inventory-less exchange system.

**Issue 5: Liquid RCRA-contaminated wastewaters.** Currently, the SWCS wastewater plant is not permitted to accept industrial waste, resulting in the disposal of liquid waste. However, the disposal and treatment via publicly owned treatment works (POTW) is allowed, with a pretreatment program, for photochemicals used in a local, commercial 1-hour photo-processing facility. The Laboratory works under more stringent regulations than a POTW.

## 7.5. Hazardous Waste Stream Descriptions

RCRA waste is dominated by fluorescent bulbs, chemicals such as ferric chloride etchant, contaminated petroleum, oils, and waters. State waste is dominated by petroleum-contaminated soils as a large component. TSCA waste is dominated by sanitary sewage sludge contaminated with PCBs. To put this in perspective, earlier figures showed pie charts dividing the waste stream of these three hazardous waste types. However, the same amount of waste is not generated in each category. Therefore, Figure 7-11 combines all three waste types to show the predominate waste stream in the hazardous waste type.

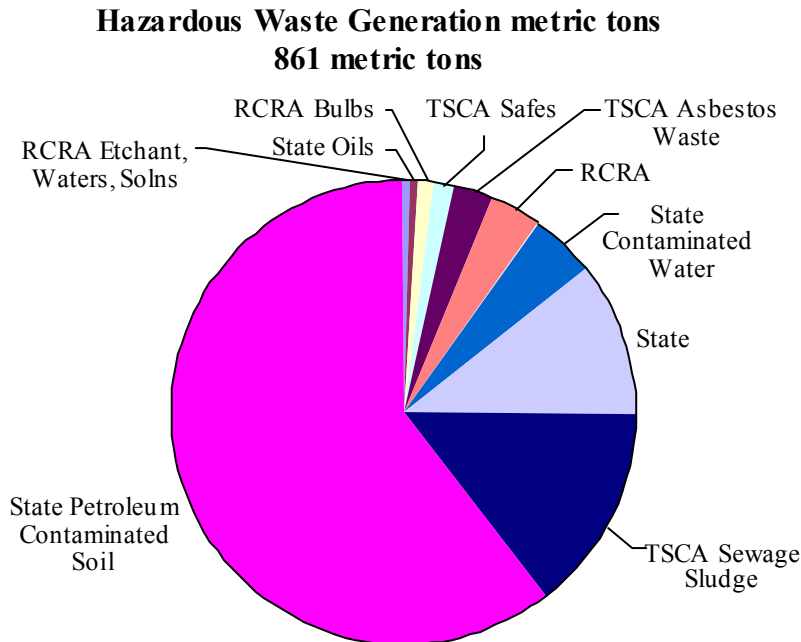


Figure 7-11. Hazardous waste generation breakdown for FY99.

#### 7.5.1. Fluorescent Bulbs

Fluorescent bulbs comprise 20% of the RCRA waste stream. Bulbs are hazardous because they contain 10 to 40 mg of mercury, both as a vapor and combined with some other material in a reservoir. Generation of these bulbs has decreased from 11.3 metric tons in FY98 to 9.3 metric tons in FY99. This reduction can be attributed to non-hazardous bulb usage increasing across the laboratory. As these non-hazardous bulbs are put in place, the hazardous bulbs expended and disposed of will slowly decrease. These bulbs are used across the Laboratory in areas such as offices, warehouses, and experimental areas.

Refer again Section 7.3, [Hazardous] Waste System Description, Figure 7-4 for the top-level process map for hazardous waste. Based on the lighting requirement, fluorescent, metal vapor, or incandescent lighting is designed and installed. A typical bulb lasts 15,000 hours (3 years). Spent bulbs are replaced by JCNNM, collected in a warehouse, and shipped to a recycler, who charges \$0.56/4-ft tube. Typically, 100,000 bulbs are replaced each year. In previous years, bulbs were replaced on a schedule; however, with the advent of the facility management model, bulbs may be replaced on a schedule or on an as-needed basis. Bulbs in radiological control facilities can become mixed waste, either through activation or surface contamination. In addition, breaking a bulb in an RCA that processes actinides always results in MLLW generation. Because fluorescent lighting is very efficient, maximizing its appropriate use is part of the Laboratory's energy conservation strategy.

### **7.5.2. Petroleum-Contaminated Soil**

Soils are contaminated with petroleum products from spills, leaks, and accidents at the Laboratory. Typically, spills happen during oil delivery and filling of oil-using equipment, equipment operation (leaks), and oil removal. Petroleum products include fuels (diesel, gasoline, etc.) and lubricating oils.

### **7.5.3. Chemical Solutions, Waters, and Etchant**

Various aqueous wastes are generated that contain both a RCRA and a non-RCRA hazardous chemical mixed with a large volume of water. These typically originate from industrial processes, maintenance activities, or accumulation in containment sumps. Photochemicals are produced in the development of photographs for publications and experiments. Various wastewaters come from containment sumps and various rinsing operations. Chiller cleaners are used for the heat exchangers at the Laboratory to remove scaling. In FY99 an industrial pretreatment unit was purchased. This was an option identified in the FY98 Roadmap. This unit will begin operation in FY00.

### **7.5.4. PCB-Contaminated Sanitary Sludge from SWSC Plant**

Sludge from the sanitary waste plant is disposed of as hazardous waste because of contamination with PCBs. Sampling upstream indicates that this contamination is coming from three contaminated floor drains in the Sigma facility.

### **7.5.5. State Contaminated Waters**

LANL currently generates approximately 50 metric tons of liquid Hazardous Waste, New Mexico Special Waste, on an annual basis. The makeup of this waste stream is comprised of waters contaminated with solids, oils, grease, antifreeze, boron, etc. This waste is disposed via TA-54, FWO-SWO. The Laboratory will pretreat this waste to meet the waste acceptance criteria (WAC) of the SWSC plant. An industrial pretreatment unit which will treat this liquid waste to meet the WAC was purchased in FY99. Procedures and a recharge program will be completed in FY00.

### **7.5.6. TSCA Asbestos Waste**

LANL currently generates approximately 25 metric tons of asbestos debris, on an annual basis. This waste is mostly generated by D&D projects. In the future, this waste stream will decrease due to the Laboratory no longer bringing new asbestos material on site.

### **7.5.7. TSCA Safes**

With asbestos a regulated TSCA material, as the safes with asbestos fireproofing put into service at the Laboratory during 40s through 70s are disposed as TSCA waste, as they are replaced. Safes purchased since the 70s do not contain this material, so as the old safes are disposed, the Laboratory will see an eventual elimination of this waste stream.

### 7.5.8 State Oils

The Laboratory use of petroleum products includes fuels (diesel, gasoline, etc.) and lubricating oils. These materials are regulated as New Mexico Special Waste, unless they exhibit a total halogen level greater than 1,000 ppm, which would require the assumption that they are mixed with hazardous waste. Generation of used oil in any quantity, mandates certain management requirements to remain in regulatory compliance. The majority of used oil at the Laboratory is recycled.

### 7.5.9 Laboratory Subcontractors

The Laboratory has several subcontractors which generate hazardous waste. In the past, great success has been achieved by including performance measures for waste minimization in the subcontractors' contracts. Further development needs to be done to include all subcontractors in hazardous waste minimization.

### 7.5.10 Green Ammunition

The Laboratory has a subcontractor which provides security. During training exercises, ammunition is used. This material is disposed as RCRA hazardous waste due to lead constituents.

## 7.6 Initiatives

### **Initiative H-1: Nonhazardous Bulb Purchase.**

- **Purchase Only Non-Hazardous Bulbs.** The majority of bulbs are purchased by JCNNM. The JCNNM relamping group is exclusively purchasing non hazardous bulbs, in response to a Laboratory policy change in FY98. The LANL Operations & Maintenance Manual, in Criterion 501 - Interior Lighting Systems, states "replacement fluorescent lamps will meet the EPA TCLP test." Therefore, in the next 3-year period this waste stream should diminish.

### **Initiative H-2: Petroleum Contaminated Soil**

- **Bioremediation.** Soils could be excavated and inoculated with bacteria for breakdown of the petroleum constituents. This would eliminate the need to dispose of the material as hazardous waste and would avoid ~100 MT annually, for a cost savings of \$1,175,000. It is estimated that setting up a site to perform bioremediation would cost a minimum of \$200,000 and could treat this entire waste stream. Operations costs are unknown. This initiative is under discussion for implementation in FY00.
- **Use of Bio-based Oils. Conversion to Nonhazardous Bio-Oils that Do Not Require Cleanup.** Soy-based bio-oils have been approved for several lubrication applications. These could be substituted into present equipment (with manufacturer's approval). In addition, new equipment could be required to operate on nonhazardous oils.

- **Energy Recoverable Pad.** The present use of Sorbent “Kitty Litter” could be replaced with use of energy recoverable mats. These mats could be placed beneath frequent spill and leak areas. The mats/spills can be burned for their Btu content.
- **Risk Analysis of Spills.** Due to the large volume of petroleum spills and the amount of money spent disposing this waste stream, the Laboratory should investigate the source of spills and their root causes. Prevention of these spills could reduce this waste stream, as well as decrease Laboratory environmental liability.

### **Initiative H-3: Chemical Solutions, Waters, and Etchant**

- **Etchant Treatment.** Etchant could be treated and no longer be a hazardous waste. Treatment options are available for ferric chloride etchant, and the product is a ceramic. This material is no longer a hazardous material.
- **MEK Minimization.** During FY98, a Green Zia analysis was applied to the HMX process. One option for future waste minimization is to implement the solutions identified in this exercise. These included various equipment needs, process changes, and procedures development.
- **Pretreat RCRA Water.** Water contaminated with RCRA constituents could be pretreated to meet the acceptance criteria for the SWSC wastewater treatment plant. A similar option is being implemented for other wastewaters.
- **Hazardous Source Reduction.** Purchases of chemicals at the Laboratory need to be evaluated. Determining before purchase how a product is going to impact a waste stream could diminish the waste stream. Currently, the laboratory has no evaluation process for chemical purchases. By working with procurement personnel, criteria could be established to find products that are comparable but not hazardous.

### **Initiative H-4: PCB-Contaminated Sanitary Sludge from SWSC Plant**

- **Eliminate PCB Contamination Source.** During FY00 the identified sources of PCB contamination in the three drains in the Sigma Building will be cleaned. This will allow the sludge to be disposed in an industrial landfill, as opposed to requiring disposal as TSCA waste.

### **Initiative H-5: State Contaminated Waters**

- **Pretreat Waters to meet the SWSC WAC.** In FY99 a recharge program was approved to treat wastewaters to meet the SWSC WAC. This program, operating procedures, and implementation will occur in FY00.

#### **Initiative H-6: TSCA Asbestos Waste**

- **Treat Friable Asbestos In Situ.** Brookhaven National Laboratory has developed a process to leave asbestos material in place. Asbestos is regulated due to the fact it is friable. By treating the material with a weak acid solution, in situ, the material is rendered no longer friable, and therefore, no longer regulated. The Laboratory could use this option in certain situations where older buildings are being remodeled rather than razed.

#### **Initiative H-7: TSCA Safes**

- **Safe Reuse Program.** The Laboratory could require that these safes be used and not replaced unless the asbestos material is a health hazard. The laboratory spends an estimated \$250,000/year on safes. A reuse program could reduce expenses, as well as the waste stream.

#### **Initiative H-8: State Oils**

- **Re-evaluate Regulatory Status of Waste Oils.** The Laboratory should re-evaluate the manifestation of waste oils. Laboratory regulatory guidance should consider whether this material should be manifested or recycled only.

#### **Initiative H-9: Laboratory Subcontractors**

- **Evaluate Subcontractor Waste Minimization.** The Laboratory should evaluate future contracts to include waste minimization.

#### **Initiative H-10: Green Ammunition**

- **Evaluate Security Subcontractor Use of Green Ammunition.** The Laboratory should evaluate the possibility green ammunition use.

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## 8.0 SOLID SANITARY WASTE

### 8.1 Summary

Most material brought into the Laboratory will leave as solid sanitary waste if it cannot be sold for reuse, salvage, or recycle. Sanitary waste is excess material that is neither radioactive nor hazardous and can be disposed of in the DOE-owned, Los-Alamos-County-operated landfill (County landfill, or landfill) according to the waste acceptance criteria of that landfill and the State of New Mexico Solid Waste Act and regulations. Solid sanitary waste includes such items as paper, cardboard, office supplies and furniture, food waste, wood, brush, and construction/demolition waste.

### 8.2 Sanitary Waste Minimization Performance

The DOE has implemented aggressive goals for waste minimization. One of the DOE's FY99 goals was to achieve a 33% reduction in sanitary waste generation as compared to FY93. Figure 8-1 shows the Laboratory's sanitary waste generation totals plotted over time compared to the waste generation goals for FY99 and FY2005.

DOE will continually strive to minimize waste, and will use the years 2005 and 2010 as measurement points. The Department's pollution prevention leadership program will go beyond compliance requirements and be based on continuous and cost-effective improvements. To achieve these goals, the Laboratory must use pollution prevention processes that lead to minimal waste generation and lowest possible life-cycle costs.

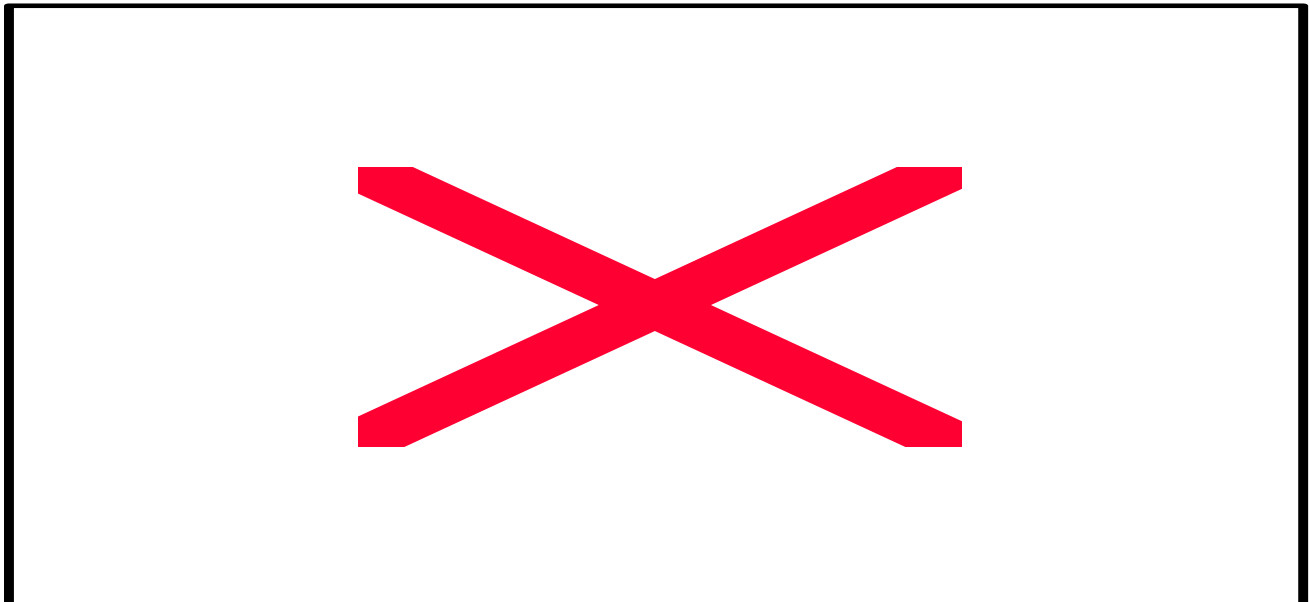


Figure 8-1. Sanitary waste stream generation goals for FY 1999 and FY 2005.

Goals that specifically apply to sanitary waste include the following:

- Reduce sanitary waste from routine operations by 75% by 2005 and by 80% by 2010, using the 1993 calendar year as baseline.
- Recycle 45% of sanitary wastes from all operations by 2005 and 50% by 2010.

### 8.3 Waste System Description

Non-hazardous, non-radioactive materials enter the Laboratory as procured items, mail, food, and various other substances such as glass, brush, and construction materials. These items are used by the Laboratory and are either recycled, reused, or salvaged, or are disposed in the County landfill. Materials disposed include such items as construction waste, food and food-contaminated wastes, paper products, glass, Styrofoam, and various other substances.

The process map for the sanitary waste type is shown in Figure 8-2.

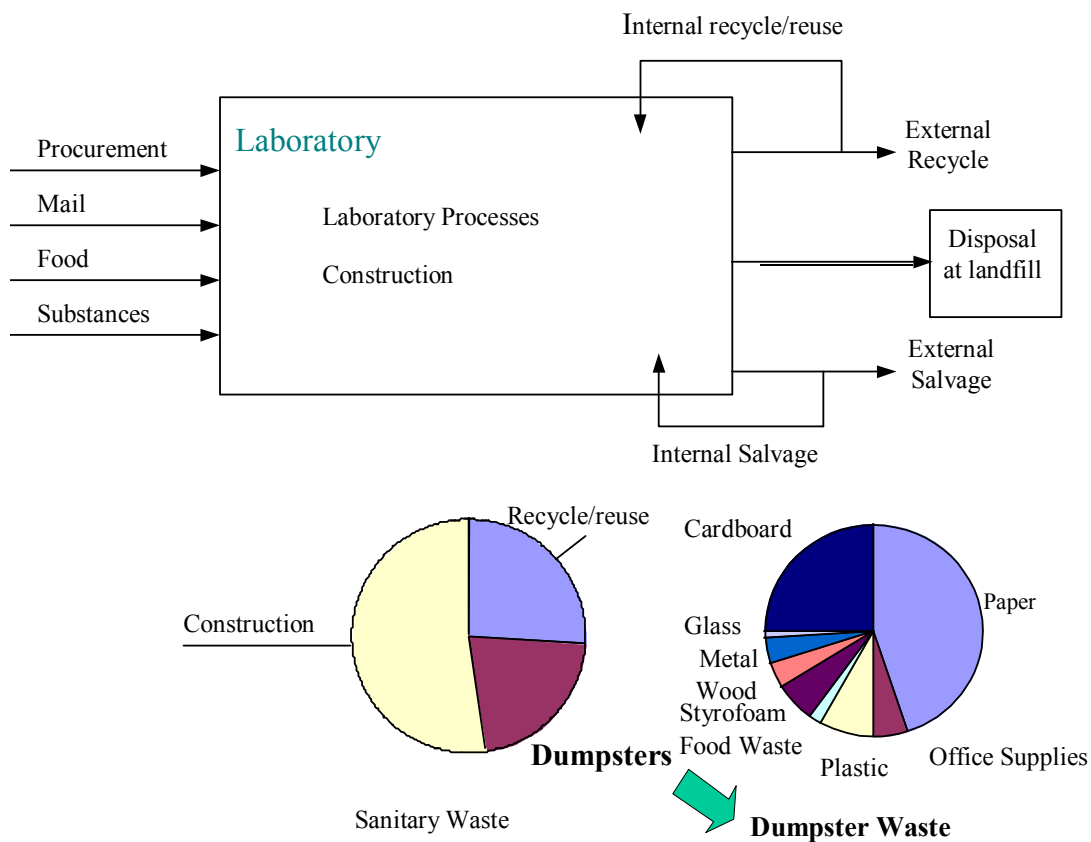


Figure 8-2. Top-level solid sanitary waste process map.

The Laboratory generates a total of more than 9500 tons of sanitary waste per year. Of this total, approximately 5000 tons is construction debris, which is disposed as sanitary waste; 2500 tons of material is recycled; and 2000 tons of discarded material is disposed in the landfill each year. The exact size of the waste streams and the year-to-year variation are difficult to assess because sanitary waste is not traced by generator or in detail by waste stream. The waste stream data are incomplete and have been updated from 1995 data.

## 8.4 Issues

**Issue 1.** Construction/demolition waste volumes are growing as the mission of the Laboratory changes and deconstruction and decommissioning operations increase.

**Issue 2.** Cost-effective brokerage for many recyclable materials is not available, due in part to the remote location of the Laboratory, but also because of a material glut on the market and a limited number of companies that are able to use the recycled material. Glass in particular poses such a problem, as no regional brokerage is currently available. Brokerage of other materials is dependant on the quality, i.e., purity, of the material, as well as market fluctuations. Brokerage of these materials is generally less expensive than disposal, but it is not a source of revenue.

**Issue 3.** It should be noted that the Los Alamos County landfill is scheduled to close in less than five years, after which time, all waste will have to be shipped to a regional landfill. A substantial increase in the total cost of sanitary waste disposal is expected as result.

## 8.5 Sanitary Waste Stream Description

The nine sanitary waste streams are described below.

### A. Construction/Demolition Waste

The largest sanitary waste stream is the construction/demolition waste stream. Construction/demolition waste is generated during the Laboratory's projects to build new facilities, upgrade existing facilities, or demolish facilities that are no longer needed. The waste generated by these projects is varied and consists primarily of dirt, concrete, asphalt, some wood items, and various metal objects. Currently, most of this waste goes directly to the landfill. The process flow map is shown below in Figure 8-3. This waste stream is growing and will continue to do so as currently planned new construction and renovation projects begin.

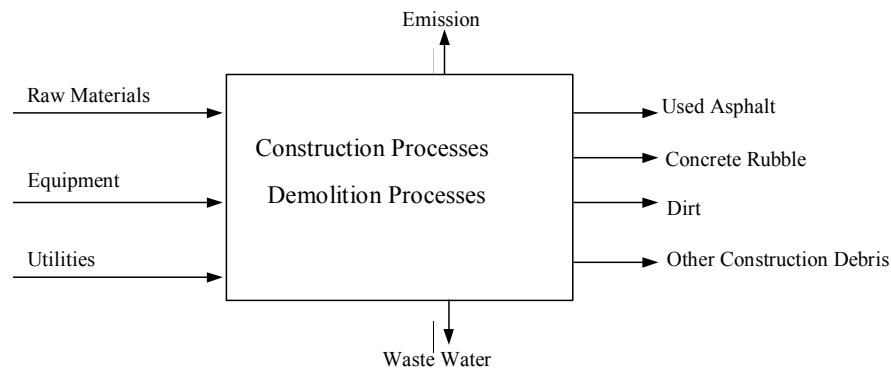


Figure 8-3. Construction/demolition process map element.

Construction/demolition projects require that raw materials and equipment be brought onto the site along with utilities, especially water. The process of construction and/or demolition produces a variety of waste but the three largest components of this waste are used asphalt, concrete rubble, and dirt. Normally, there is no sorting and these items are taken directly to the landfill. Even so, the quantities for each of these materials are not well known. Prior to May, 1998, these materials were reused as fill to construct a land bridge between two areas of the Laboratory, but that activity was halted due o environmental and regulatory issues. However, there are several other options for the reuse of construction/demolition debris.

## B. Procured Equipment and Supplies

Every year the Laboratory procures quantities of equipment and supplies to enable it to fulfill its mission. This procurement ranges from computers, office supplies, and office furniture to scientific instruments and vehicles. Items that are valuable enough to be assigned a property number must be salvaged when they are no longer needed. Items that have some useful life left can be reused within the Laboratory or sold to individuals, organizations, or off-site vendors for reuse or recycling. The Laboratory currently disposes of approximately 2500 tons of used equipment and supplies per year through the Property Disposal operations. The process element map is shown in Figure 8-4. There are three major components to the procured materials stream; however, since supplies and equipment are handled in virtually identical ways at the Laboratory, they have been aggregated into a single waste stream in the following discussion. The handling of paper products is very different and much more complex, and is treated as a separate waste stream for that reason.

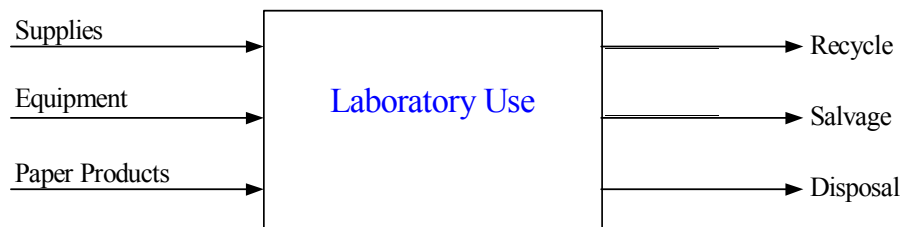


Figure 8-4. Procured equipment.

- **Paper Products**

The Laboratory purchases about 500 tons of paper products each year. These products are used in a variety of ways but the bulk of the product is used in offices for printing, copying, faxing, and other office support uses. The Process element map for paper product usage at the Laboratory is shown in Figure 8-5.

Paper is used to produce various forms of unclassified, classified, or sensitive documents, and each has a different path to disposal. Unclassified products are normally disposed in either green desk-side bins which are taken directly to recycle, or in trash bins which are taken to the Materials Recycle Facility (MRF) for sorting. The material recovered from sorting is recycled unless contaminated with food waste, in which case it is sent to the landfill. Some unclassified

materials are sent to storage or to archiving. This material is held in storage for varying periods before it is disposed. Some unclassified, as well as sensitive, material may be distributed to radiation control areas (RCAs) where it is subject to radioactive contamination and disposal as low-level waste. Uncontaminated paper from RCAs may be disposed in “*Green is Clean*” bins and sent to be characterized and recycled.

Sensitive materials should be shredded but it is occasionally disposed in recycle or trash bins; from there it follows the same path to disposal as unclassified material. Although strip shredded sensitive material is sent to recycle, cross-cut shredded material currently cannot be recycled and is sent to the landfill.

Classified material is shredded and sent to the landfill.

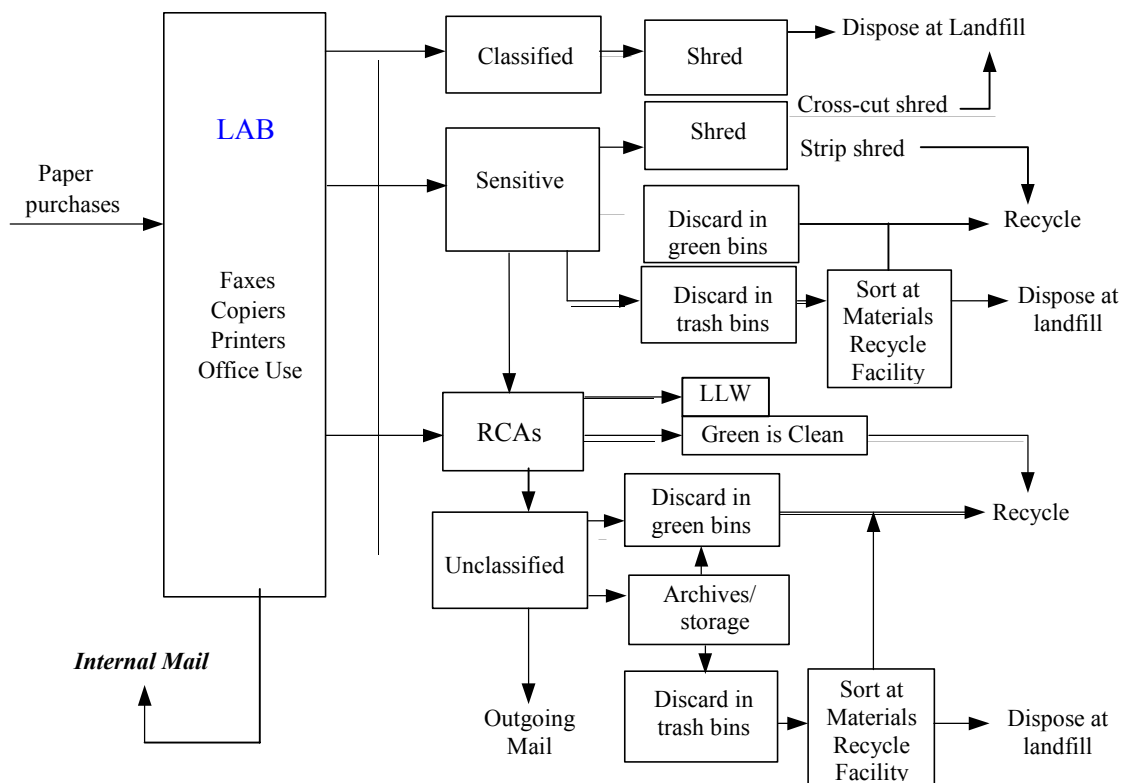


Figure 8-5. Paper product usage.

In past years virtually all the paper that was disposed in the trash bins went to the landfill. With the operation of the MRF, much of that paper will be recovered for recycle. The MRF has been in operation for only a short time but with continued operation, better statistics on rates of paper recovery will become available. Certainly a much greater fraction of the total discarded paper will be sent to recycling. However, even with the MRF operating, there are a number of opportunities to reduce paper use and increase recycling at the Laboratory .

- **Office Supplies/Equipment**

The Laboratory purchases a variety of office supplies and equipment including office furniture, office partitions, computers, faxes, printers, and desk accessories. Equipment with assigned property numbers is salvaged at the end of its use. Items that have been replaced or are no longer needed but have some useful life left can be recycled. These items can be reused within the Laboratory or sold to individuals, organizations, or vendors off site for recycling. Items that cannot be recycled, salvaged or otherwise reused are disposed at the landfill. The size of this waste stream is not known. The process map for office supplies/equipment is shown in Figure 8-6.

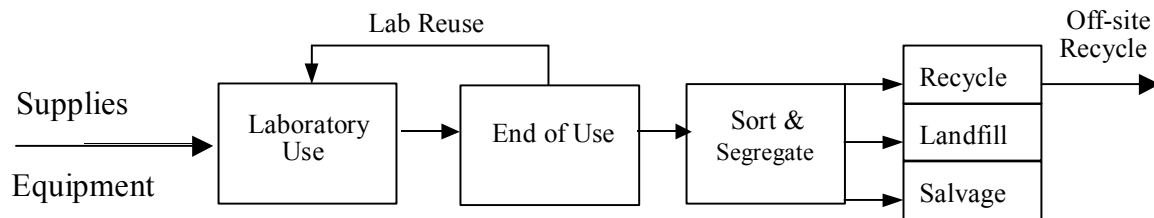


Figure 8-6. Office supplies and equipment.

### C. Mail

Every year the Laboratory receives and distributes 714 MT of mail. This mail includes junk mail, catalogs, phone directories and various documents, as well as business mail. The mail received by the Laboratory includes a small amount of classified mail. The process flow diagram for the mail waste stream is shown in Figure 8-7.

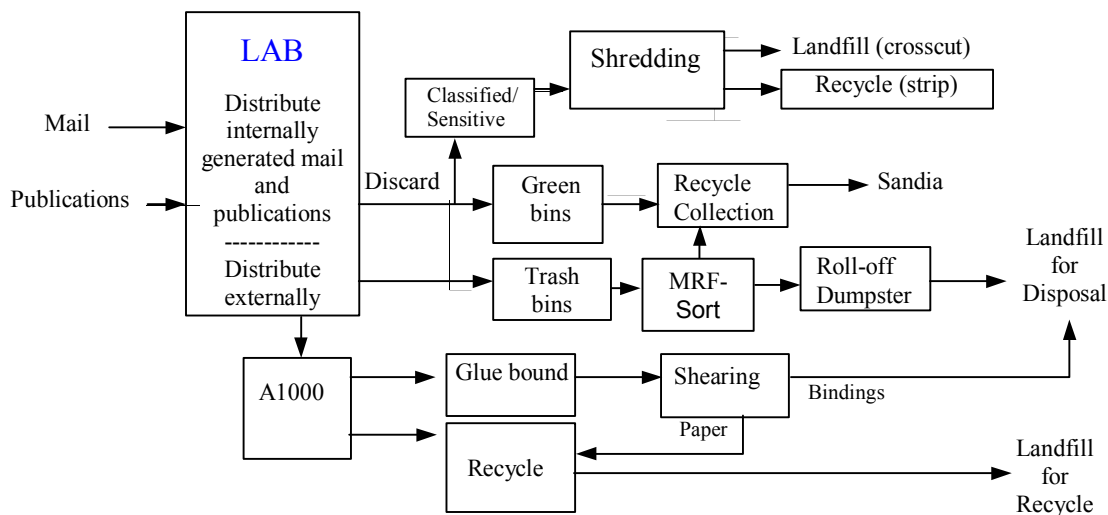


Figure 8-7. Mail and document distribution and disposal.

Mail, including internally generated mail, is received by the Laboratory and distributed. Any unwanted mail can be sent by the recipient to Mail Stop A1000 for sorting and recycle. Documents such as catalogs and directories that are glue bound must first have the bindings sheared off before the paper is recycled. The bindings are sent to the landfill for disposal. Mail is also disposed by discarding in green desk-side containers or trash bins. The contents of the green containers are sent to recycle while the contents of the trash bins are sorted for recyclable materials at the MRF. Classified material may not be disposed unless it has been security (cross-cut) shredded. The strip shredded material can be recycled, but cross-cut shredded material currently goes to the landfill.

With the advent of MRF operations, the opportunity to recover nearly all the discarded recyclable mail will be realized. The emphasis will then be on reducing the source of unwanted mail.

#### D. Cardboard

Cardboard enters the Laboratory in one of two ways: either as packaging materials or as newly purchased moving boxes. Some of the cardboard, particularly cardboard moving boxes, is routinely recycled for reuse. Other cardboard is discarded to either the dedicated cardboard collection roll-offs or the trash dumpsters. Dumpster trash is taken to the MRF and sorted, where recyclable cardboard is recovered. Wet or food-contaminated cardboard is sent to the landfill for disposal. The cardboard waste stream is graphically depicted in Figure 8-8.

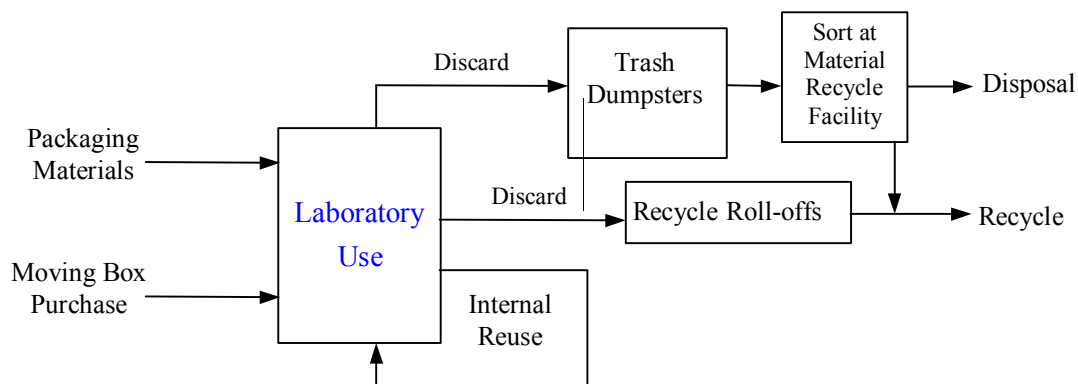


Figure 8-8. Cardboard waste.

With the operation of the MRF, recovery of virtually all recyclable cardboard is possible. The only cardboard that will go to the landfill for disposal will be contaminated cardboard. With the capture of all the recyclable cardboard, emphasis will be placed on reducing the cardboard source and increasing reuse. There are several options for achieving these goals.

#### E. Plastics

Plastics and foam are used for many purposes at the Laboratory and constitutes the third largest component of dumpster waste. Currently there is no plastic recovery/recycle program at the Laboratory. The roadmap element for plastics and foam is shown below in Figure 8-9.

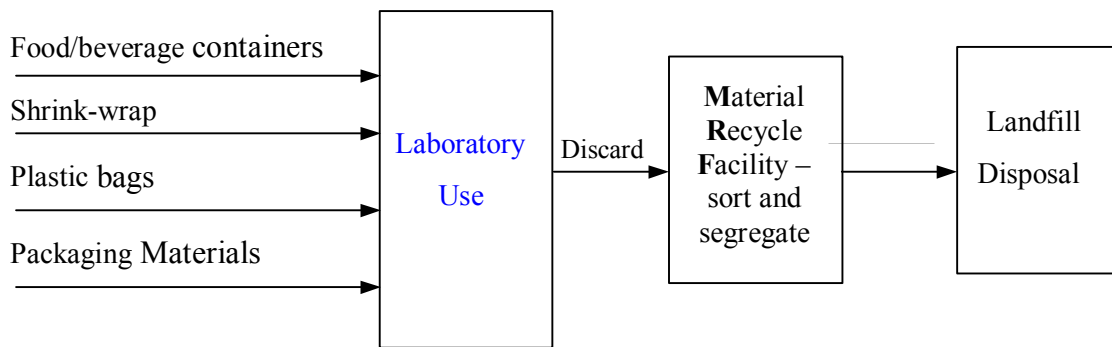


Figure 8-9. Plastics and foam waste stream.

Plastics and foam enter the Laboratory as containers, shrink wrap, plastic bags, and as packaging materials. After use the materials are discarded and those items discarded to trash bins are sorted at the MRF; but since there is currently no program to aggregate and recycle these items, they are sent to the landfill.

#### **F. Food and Food-Contaminated Materials**

Food products enter the Laboratory waste streams either through food service from one of the three cafeterias, or from food brought into the Laboratory from off-site. In FY 1998 the three cafeterias served 622,248 meals. Sixty five percent of the meals were served at the TA-3 cafeteria, which generated 166 tons of food and food contaminated waste. Assuming the same proportional rate of generation for the other cafeterias, the total waste stream is estimated at 255 tons. The number of lunches brought onsite per day is not known, but is estimated at 3000. The residue from each lunch is approximately 0.5 lbs. of food and food contaminated waste, with a resultant waste stream of approximately 141 tons per year. In addition, mobile food service vehicles and food catering serve an estimated 2000 meals per day, with an estimated waste stream of 100 tons per year. If these estimates are reasonably accurate, it means that food waste exceeds 500 tons per year and equates to more than 25% of the sanitary waste stream. In any event, a minimum of 400 tons (or 20%) of the sanitary waste is generated from this stream. The roadmap element for food and food contaminated waste is shown in Figure 8-10.

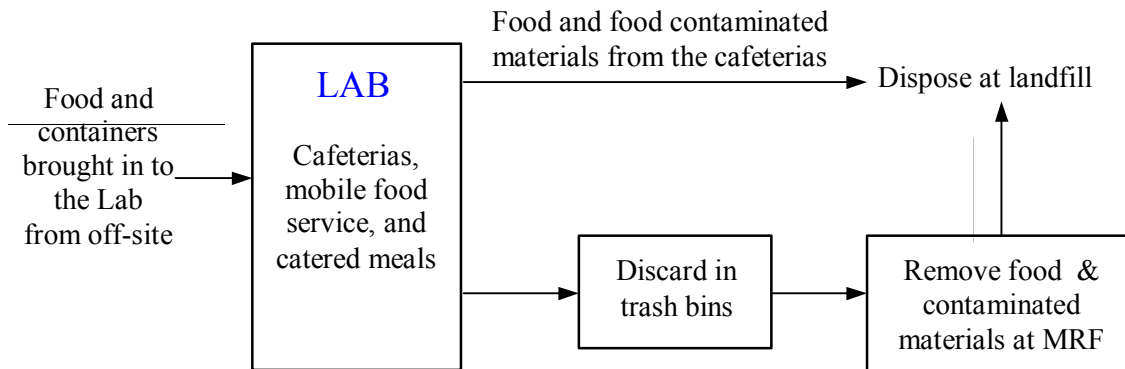


Figure 8-10. Food and food-contaminated waste.

All the food and food-contaminated wastes generated at the Laboratory are currently sent to the landfill. This waste stream is particularly intractable since there are few or no realistic options for reducing the waste stream.

### G. Sludge

The Laboratory's sanitary wastewater collection system and treatment plant routinely generates sludge and grit that must be disposed at off-site locations. An average of 200 metric tons of sludge and grit are typically generated and disposed per year.

During the past few years, EPA has required the Laboratory to manage and dispose of the sludge and grit as TSCA waste because PCBs were detected in the grit and screenings. The Laboratory's ESH Program has identified the source of the PCBs to be legacy contamination from past spill events in locations that could have possibly contaminated the sanitary collection system. The Laboratory, DOE/Los Alamos Area Office (LAAO) and EPA have been negotiating this issue and projects are underway to identify, clean, and remove the PCB source. These actions will reduce the waste management costs, as well as the environmental liability, associated with the SWSC plant sludge and grit by removing it from a TSCA regulatory status.

Once potential sources have been eliminated and the SWSC plant influent is demonstrated to be free from PCBs, the sludge and grit will become part of the Solid/Sanitary waste stream and can be managed at significant cost savings to the Laboratory. The nonhazardous sludge and grit will be managed for disposal at a permitted landfill in compliance with Clean Water Act and the New Mexico Solid Waste Management Regulations (NMSWMR). The grit must meet the disposal requirements for the Los Alamos County Landfill and the sludge will most likely be transported to the permitted landfill in Rio Rancho, New Mexico.

Once the sludge and grit are determined to meet the requirements of NMSWMR, initiatives will be needed to prevent future contamination of the SWSC system and to minimize the volume and toxicity of the material disposed.

## 8.6 Initiatives

### **Initiative S-1: Construction/Demolition**

- **Asphalt Reuse.** Reuse of non-contaminated asphalt is currently possible if the asphalt can be segregated from other debris. Asphalt that is milled as it is removed from the surface can be readily re-used as road base, temporary parking lots, temporary patching, or to stabilize road shoulders.
- **Dirt Reuse.** Dirt for fill use also would reduce the volume of debris going to the landfill but may require storage for some period before use. Fill dirt can be mixed with compost to create top soil for re-application around the Laboratory.
- **Concrete Reuse.** Concrete rubble can be crushed for use as an aggregate or base course; it may also be used for caps at restoration projects.

### **Initiative S-2: Procured Equipment and Supplies**

#### **Paper Products**

- **Double-sided copies.** Much of the printing and copying at the Laboratory is currently done single-sided. An immediate reduction in the quantity of paper used will be realized by adopting double-sided copying. Employees are being actively encouraged to print on both sides of the page; to purchase printers and copiers that are duplex-capable; and to reuse one-sided copies for scratch paper and/or for printing drafts.
- **Electronic transmittal.** Increased use of electronic mail (both internal and external) will reduce total paper usage, as could electronic archival of documents. A substantial reduction in printing costs and associated waste will be realized by transmitting and storing documents electronically.
- **Additional items in paper recycle system.** The current paper recycle program is limited to white and pastel paper; options for including other types of paper products in this mix are being evaluated.
- **Compost cross-cut shredded paper.** Composting shredded paper would completely eliminate this component of the waste stream and would also improve security aspects of document disposal.
- **Identify local broker for paper product recycling.** Currently, all of the different components of the paper products recycling programs are coordinated through different brokers. Using one broker or recycling facility for all of the different paper products would likely reduce costs and improve efficiencies. This option is currently being evaluated.

## **Office Supplies/Equipment**

- **Improve internal reuse.** Internal reuse is made more difficult because there is no mechanism by which the availability of equipment can easily be made known. In order to encourage internal reuse, a central web page will be developed for people to publish the availability of unwanted equipment.
- **Improve acquisition efficiency.** People will not use the salvage system if it is more difficult than ordering new equipment. An on-line salvage catalog will be established and maintained to increase equipment “orders” from this source.
- **Improve quality of material offered.** Property being salvaged is subject to damage due to multiple handling and improper storage. Options for reducing damage during removal, transportation and/or storage are being evaluated.

## **Initiative S-3: Mail**

- **Reduction of “junk mail.”** A substantial fraction of the mail consists of recurring, unwanted "junk" mail. A centralized stop-mail service for “junk mail” is currently in the pilot phase. This service can be used by any Laboratory employee that wishes to request removal of their name from a mailing list.
- **Eliminate paper phonebooks.** Paper phonebooks are widely used and are difficult to recycle. US West directories, which are routinely distributed to all employees, will be eliminated as a source of waste by restricting delivery and asking employees to use the “on-line” directory instead. Approximately 22 MT of waste per year can be avoided in this way.
- **Additional items in paper recycle system.** The current paper recycle program is limited to white and pastel paper; options for including other types of paper products (mail items) in this mix are being evaluated.
- **Increase use of MS A1000.** Although MS A1000 is widely used as a means of recycling various materials, many employees are still unaware of its existence. A publicity campaign will be developed to increase awareness; self-inking stamps (with the A1000 logo) will also be distributed to each mail stop within the Laboratory to encourage use of this program.

## **Initiative S-4: Cardboard**

- **Increase quantity of recyclable cardboard.** Commingling of food wastes with other waste leads to unnecessary contamination of cardboard and paper waste, rendering them non-recyclable. Separate dumpsters have been provided to collect trash from the cafeterias to prevent commingling. The food service contract will be evaluated/revised to encourage better separation of recyclable cardboard.

- **Reduce cardboard at the source.** Much of the cardboard entering the Laboratory is the result of packaging. Large, bulk purchases are frequently over-packed (many small boxes inside larger boxes) which results in the use of excess packing material, including cardboard. The purchasing department will work with vendors to request that minimum packaging be used for large bulk purchases.
- **Availability of recycle containers.** It is frequently more difficult to discard cardboard in a designated recycle bin than it is to discard it in a dumpster. The County currently owns and services the collection bins used for cardboard, but do not have additional bins available for Laboratory use. However, because cardboard is also recovered at the MRF, cardboard can now be placed in trash dumpsters when a dedicated collection bin is unavailable.
- **Increase value of cardboard as a commodity.** Purchase and install a cardboard baler to increase ease of handling and to increase the market value of the recycled material.
- **Reuse moving boxes.** Moving boxes are frequently discarded after use even though they are perfectly serviceable. Reuse of moving boxes can be encouraged by providing a central point to return them for reuse or by providing a used box pickup service.

#### **Initiative S-5: Plastics**

- **Implement a plastic recycling program.** The Laboratory currently has no recycle/reuse program for plastic waste. The first steps toward an effective recycling program (now that the MRF is operational) is to locate a broker for LPDE materials and to procure a baler to reduce the volume of materials and increase their market value.
- **Reuse packing materials.** Packing materials such as foam peanuts can be reused. A reuse program for used packing materials will be developed and publicized.

#### **Initiative S-6: Food and Food Contaminated Materials**

- **Prevent commingling.** Food waste that is discarded in waste bins can contaminate other wastes and render them non-recyclable. The food service contractor (ARAMARK) will handle food waste as a separate waste stream to minimize the possibility of food waste contaminating recyclable materials.
- **Investigate composting.** There is currently no program to recycle any food waste at the Laboratory. This policy means that any food waste generated goes to the landfill. Realistically there are few opportunities to reduce this waste stream. Initiating a limited composting program for food waste may be a possibility. Composted food waste could be blended with sludge and dirt to make a planting mix for use by Laboratory landscaping.

**Initiative S-7: Sludge**

- **Investigate composting.** There is currently no program to recycle sludge at the Laboratory. Realistically there are few opportunities to reduce this waste stream. After the sludge from the SWSC plant is re-characterized as sanitary (rather than TSCA) waste, initiating a limited composting program may be a possibility. The sludge could be blended with composted food waste and dirt to make a planting mix for use by Laboratory landscaping.

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## 9.0 CONSTRUCTION

### 9.1 Summary

The Laboratory will spend over 4.4 billion dollars in new construction and upgrading facilities in the next ten years. Project Management Division (PMD), will be the driving force behind developing and completing the construction of new facilities and upgrading current facilities. There will be large amounts of waste generated from the building of new facilities and a substantial savings of water, energy, and process wastes that can occur if facilities proactively include pollution prevention in the planning stage. Many of the wastes generated in industry are similar to the waste generated throughout the Laboratory during construction projects. Figure 9-1 displays the percentages of wastes by weight generated at a typical construction site. The Laboratory currently does not have comprehensive data on the amount of waste generated from construction projects at the Laboratory, but all waste that enters the Los Alamos County Landfill is tracked. In FY98 560 metric tons and in FY99 540 metric tons of Johnson Controls Northern New Mexico (JCNNM) construction debris entered the landfill.

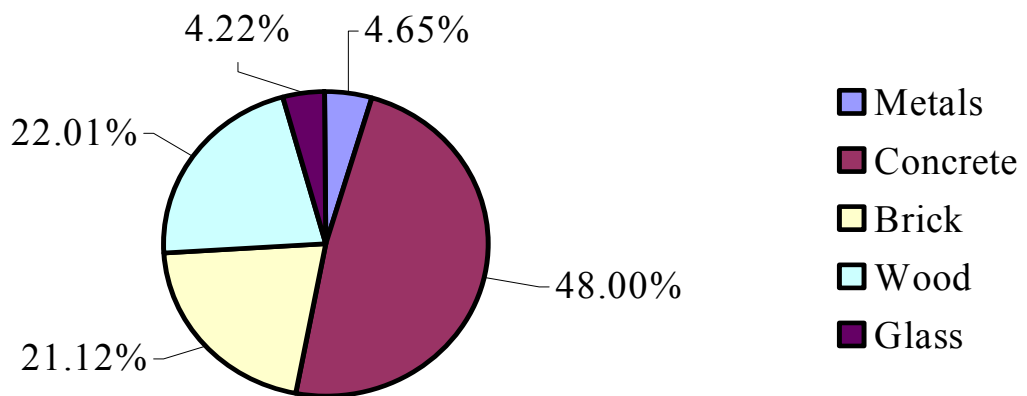


Figure 9-1. Typical building content in the United States.

In accordance with the DOE Waste Minimization Program, pollution prevention and waste minimization (P2/WMin) considerations should be incorporated into the design and operation plans of new facilities, as stated in the *Waste Minimization/Pollution Prevention Cross Cut Plan* (DOE 1994b) and in DOE Orders 5400.1 and 5820.2A. Pollution prevention includes practices that reduce the use of raw materials, energy, water, and protect natural resources by conservation or more efficient use. Currently the Laboratory does not have a waste minimization program for construction projects. This roadmap is the first step in implementing a program.

The construction roadmap will address the impacts that the Laboratory is currently facing and methods for eliminating them. Impacts of Laboratory construction include waste generation, effluents, air emissions, energy usage, water usage, and materials procured. As the most significant impacts are eliminated or put on a track for elimination, future versions of the roadmap will address the next most significant environmental impacts.

## 9.2 Construction Waste Minimization Performance

This is the first year that a construction related waste minimization program has been implemented at the Laboratory. The inclusion of construction waste minimization in the Environmental Stewardship Roadmap is one of the first steps to formally establishing a program within the Laboratory. The Environmental Stewardship Office is currently establishing contacts within the Project Management Division to further develop the program.

## 9.3 System Description

The Laboratory's construction and upgrading activities are organized into five phases: Preconceptual, Conceptual, Execution, Operations, and Facility Shutdown shown in Figure 9-2. Although construction at the Laboratory includes a wide variety of projects including nuclear and non-nuclear facility construction and upgrades, all projects will follow the five basic construction phases.

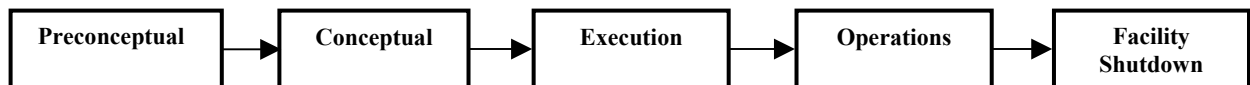


Figure 9-2. Project management construction phases

The Preconceptual stage is the initial planning stage. All of the preliminary work to get a project started is accomplished in this stage including assigning the project leader, selecting the project team, defining the scope of the project and a deciding whether the project is feasible.

The Conceptual stage is where the design for the project is established. In the conceptual stage the design plan is prepared and a preliminary budget and project schedule is developed.

In the Execution stage the design is implemented and the facility is constructed. The Project Execution Plan (PEP) is developed, the Architect Engineer (A/E) contractor is established, and project specific plans are generated. Special Studies/Value engineering requirements are preformed. The Environmental Safety and Health (ES&H) Regulatory requirements are defined and plans and procedures are developed. The cost and project schedule is updated.

Periodic inspections of the construction site occur to assure that safety and other project concerns are met.

The Operations stage is when project management closes out its authority over the project and turns over the completed facility to the operating group. During the project management closeout all final documentation is completed including the operations procedures, maintenance procedures and the cost/schedule review.

Project Management will step back into the system once operations at the facility are completed and shutdown of the facility is planned. At this point the cycle will start again with the initiation of the Preconceptual stage moving through Conceptual and Execution. Environmental Decontamination and Decommissioning (D&D) performs facility decommissioning at the Laboratory. Activities performed by Environmental D&D are outside of the scope of this roadmap. Only waste streams generated from facility upgrades will be discussed.

#### **9.4 Issues**

There are several issues affecting the generation of waste and the use of natural resources throughout the phases of the construction process.

**Issue 1:** The estimated lifetime of the County Landfill is 5 years. Of all of the material going to the landfill, approximately 5000 tons comes from construction or demolition.

**Issue 2:** Construction/demolition waste volumes are growing as the mission of the Laboratory changes and deconstruction and decommissioning operations increase.

**Issue 3:** Construction debris (soil, concrete, rubble, and asphalt) that will be generated from the proposed site revitalization projects does not currently have a local disposal pathway. The estimated amount of construction debris generated on a yearly basis for the next ten years may far surpass the allowable yearly amount of the County Landfill.

**Issue 4:** If the Laboratory was forced to ship construction debris offsite for disposal, the cost to the Laboratory would increase from fees currently paid. The Laboratory would not only be paying the fee that the landfill would charge, but would also be forced to pay a shipping fee.

**Issue 5:** The cost of construction waste disposal is not accurately known. Dumpster pickups are not tracked to specific generators but are tracked at the Facility Management Unit (FMU) level. Construction debris (soil, concrete, rubble, and asphalt) is disposed by the construction contractor to the County Landfill (or elsewhere) or through JCNNM to the landfill. Currently, debris disposed by a contractor is not included in the Laboratory's sanitary waste measures.

**Issue 6:** Operation of the Laboratory requires the consumption of water, natural gas and electricity. Water consumption at the Laboratory and to a much lesser extent natural gas usage is driven by electrical demand. Electrical demand at the Laboratory is growing and over the next five years demand associated with known projects is likely to increase by as much as 25MW.

**Issue 7:** Opportunities for implementing pollution prevention measures decrease with each successive design stage. The project schedule and budget are established in the Preconceptual and Conceptual stages. After the schedule and budget are set the addition of P2/WMin techniques in the project is difficult.

## 9.5 Construction Waste Streams

Although all five phases in the Laboratory's construction project management system affect the waste generation, effluents, air emissions, energy usage, water usage, and materials procured over the life-time of a facility only the Execution, Operation and Shutdown phases generate waste streams. These systems are described in further detail below.

### A. Execution Phase Waste Streams

The Execution phase consists of several subphases as seen in Figure 9-3. During the preliminary design, design, and engineering and inspection subphases no waste is actually generated. All the waste generated during the execution phase is generated during the construction sub-phase which includes preconstruction and construction activities.

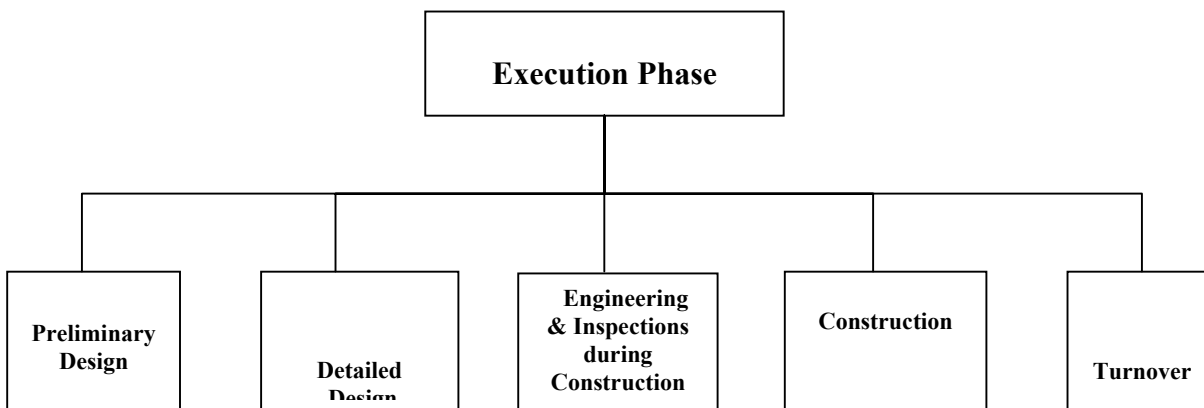


Figure 9-3. Construction project execution phase.

Preconstruction activities are mainly concerned with preparing the site for construction of the new facility. This could include clearing trees and brush, and excavating and leveling of the ground. The process diagram for preconstruction (Fig. 9-4) shows the possible inputs and outputs. Both energy and water are utilized during the preconstruction process. Waste streams produced due to this process include air emissions of excessive dust and equipment exhaust and leaks, aqueous losses of waste oils and coolants from the equipment, spills and storm water runoff, and solid waste consisting of metals, mixed rubble, wood, glass, plastics, and soil.

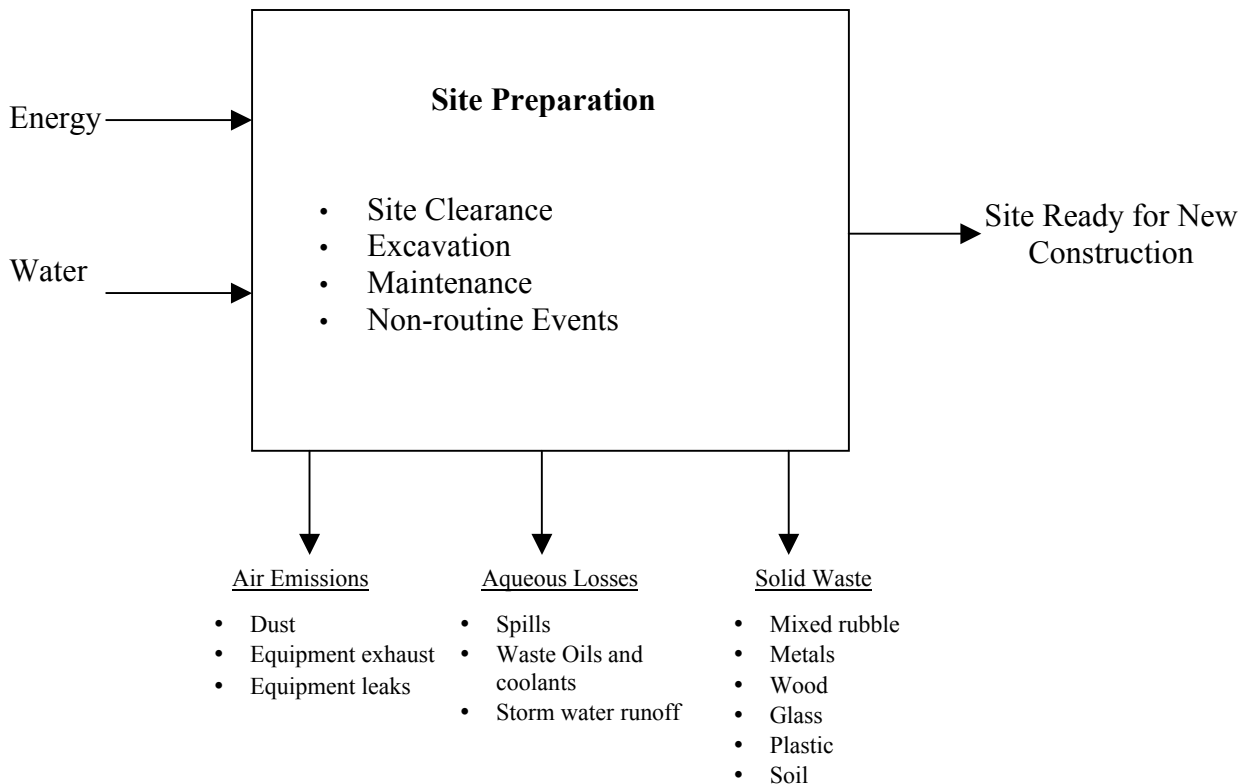


Figure 9-4. Anticipated waste streams for preparing a site for construction.

After preconstruction activities are completed, construction of the new facility can begin. Figure 9-5 shows the anticipated waste streams for construction of a new facility. Inputs to the system include water, energy and building materials. Depending on the type of facility the amounts and types of inputs can vary.

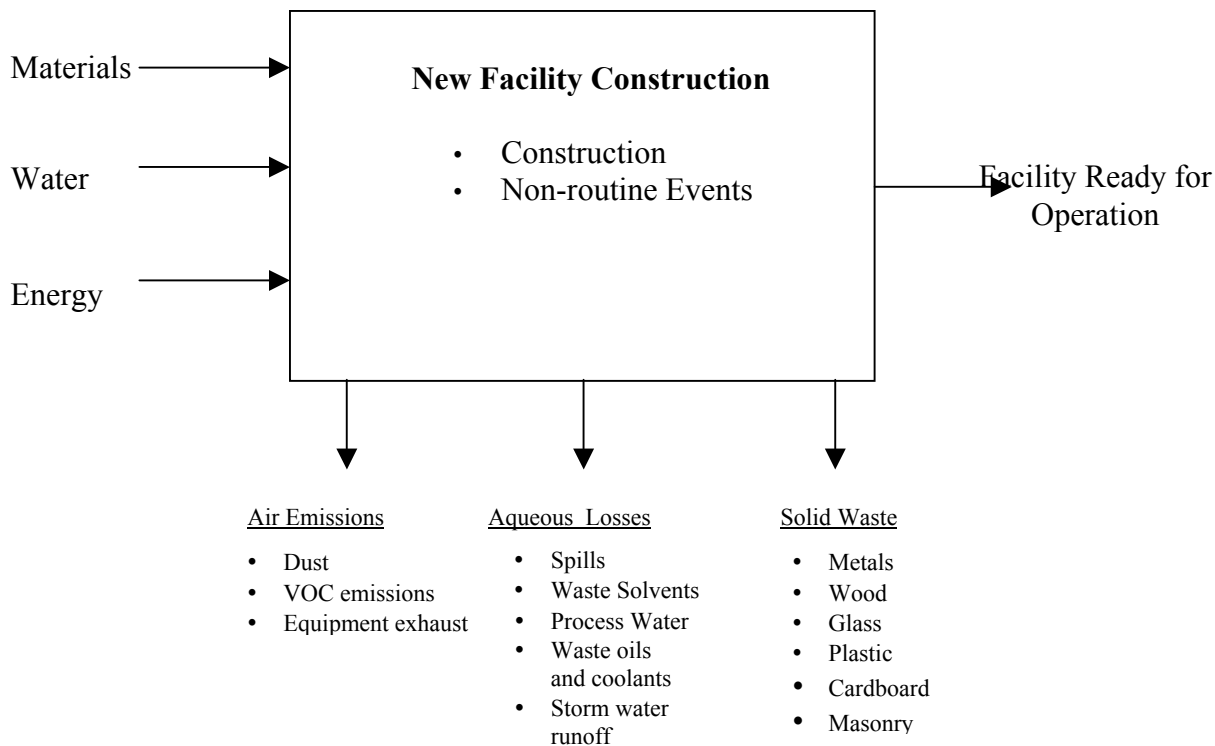


Figure 9-5. Anticipated waste streams for construction of a new facility.

Many of the wastes produced are similar to the site preparation wastes with some variations. Air emissions will not only include fugitive dust emissions and equipment exhaust and leaks, but also the possibility of volatile organic carbon (VOC) emissions from painting operations. Aqueous losses will consist of used waste solvents, process water, waste oils and coolants from the equipment, spills, and storm water runoff. Solid wastes generated will include many of the same wastes as the preconstruction phase including metals, wood, glass, and plastic. Cardboard waste and excess masonry materials will also be generated during the construction process. After the construction of the facility has been completed project management turns the facility over to the operating group.

## **B. Operations**

The Operations phase of a facility (Fig. 9-6) includes both the startup of the facility and the continued operation throughout the facility's lifetime.

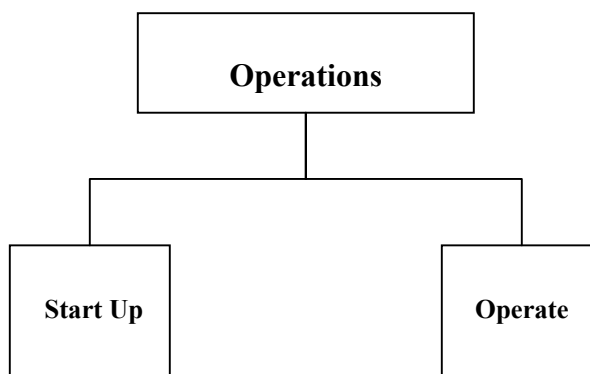


Figure 9-6. Construction project operations phase

Activities included in the operation of the facility include facility maintenance and repair, utilities, and janitorial support. Figure 9-7 shows the anticipated waste streams for the operation of a facility. All facilities will consume both water and energy. Depending on the facility the amount and types of materials consumed will vary.

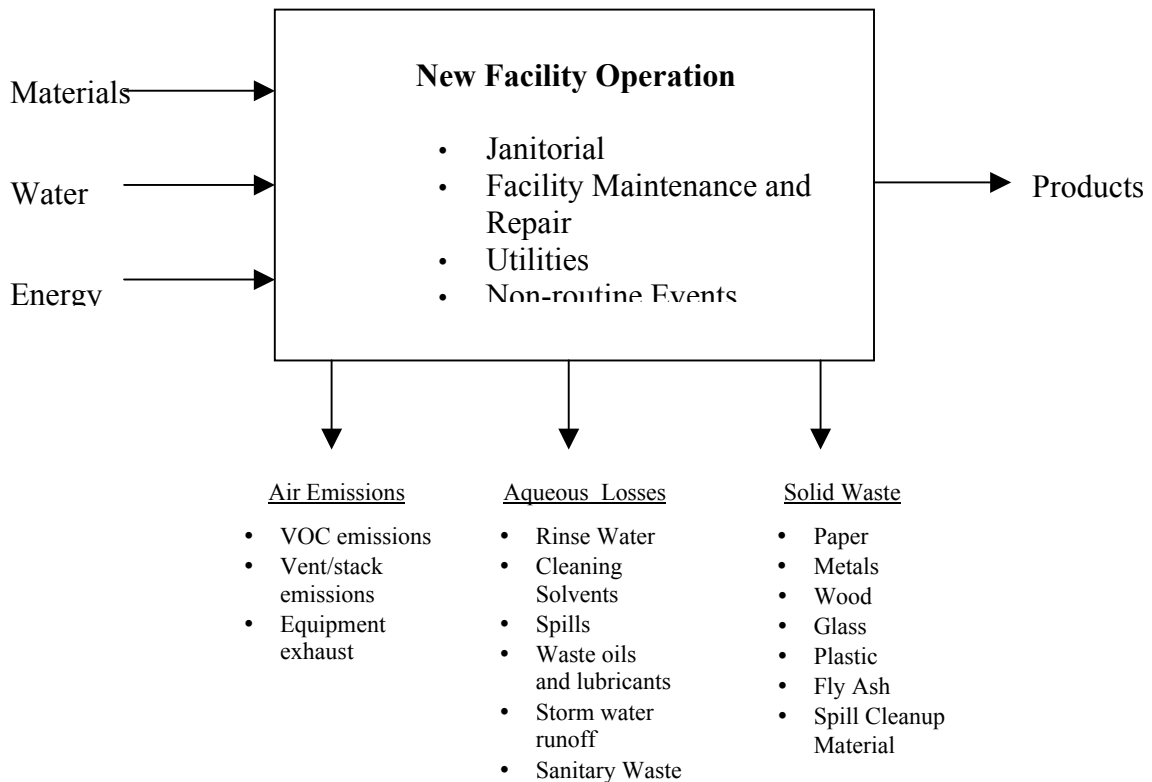


Figure 9-7. Anticipated waste streams for the operation of a facility

Air emissions are highly dependent on the type of facility, but can include VOC emissions, vent or stack emissions, and equipment exhaust and leaks. Aqueous losses are less dependent on the type of facility, but can still vary. All facilities will have a sanitary waste stream and used cleaning solvents. Depending on the facility rinse water, waste oils and lubricants, and storm water runoff streams can vary greatly on quantity and sources. Unlike the Execution stage where a large amount of solid waste is generated in a short period of time depending on the facility the amount of solid waste generated during the facilities lifetime will vary greatly. Usually the largest waste stream in an operating facility is paper waste. Other waste streams can include metals, wood glass, plastic, fly ash from exhaust stacks, and spill cleanup material.

### C. Shut-down

After the lifetime of the facility there are two options either to upgrade the facility to meet future needs or to decommission the facility. In either case the shutdown of the facility will include the Preconceptual, Conceptual and Execution subphases as seen in Figure 9-8. During the Preconceptual and Conceptual subphase the design plan for the upgrade/decommissioning is established and during the Execution subphase the plan is carried out.

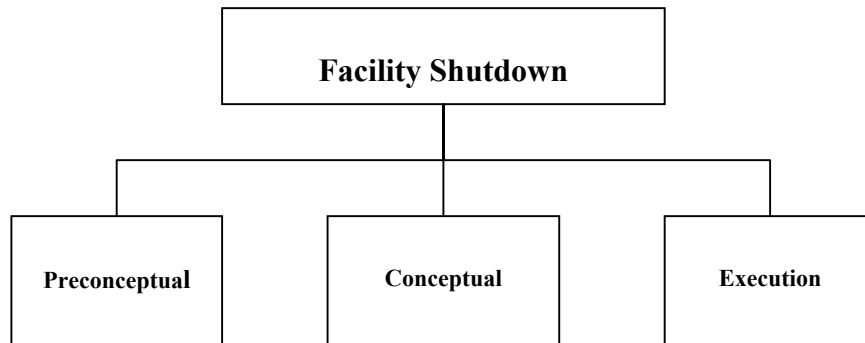


Figure 9-8. Construction project facility shutdown phase.

There is a significant amount of waste that can be generated during the facility shutdown/upgrade stage. The anticipated waste streams from the shutdown of a facility are shown in Figure 9-9. The facility shutdown can include dismantlement of equipment, site clearance, utilities, and maintenance during the shutdown. Waste streams generated are very similar to site preparation. Air emissions include fugitive dust emissions and equipment exhaust and leaks. Aqueous losses will include waste oils and lubricants, spills, and storm water runoff. Solid waste generated will be the major contributor by volume to the total amount of waste generated. Solid waste streams include paper, mixed rubble, metals, wood, glass, plastic, and spill clean up material.

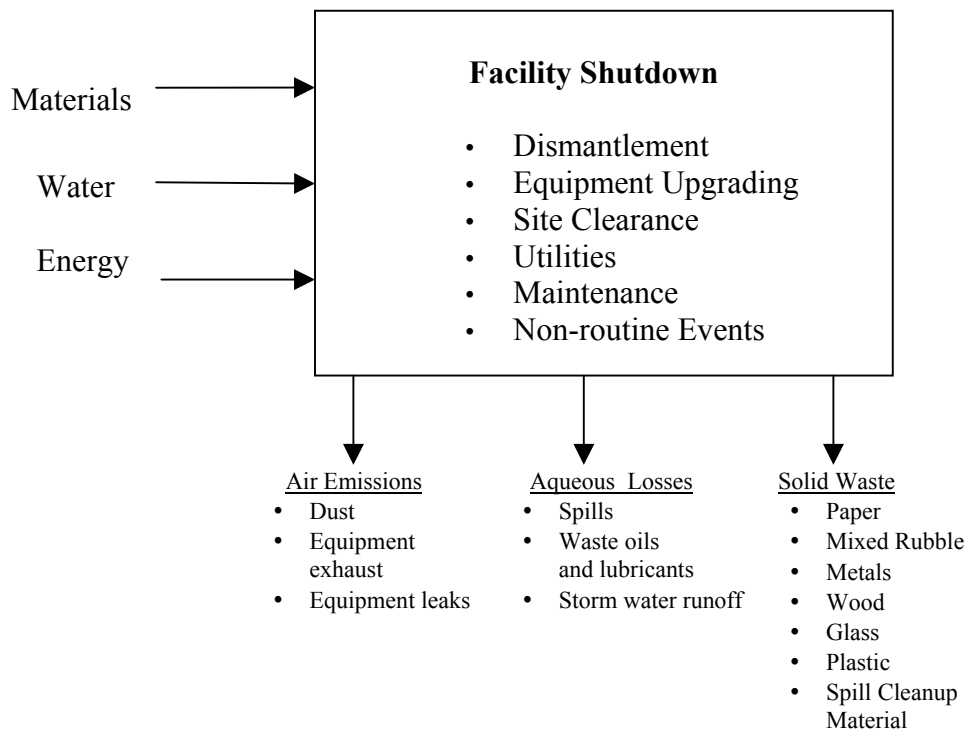


Figure 9-9. Anticipated waste streams for the shutdown of a facility.

## 9.6 Initiatives

### A. Execution Initiatives

#### **Initiative C-1: Include P2 planning in Preconceptual and Conceptual Stages**

- It is estimated that 70% of a system's life cycle costs are determined in the design cycle of the system. For this reason, it is critical to incorporate P2/WMin concepts as early as possible in the project's cycle. Opportunities for implementing pollution prevention measures decrease with each successive design stage. The project schedule and budget are established in the Preconceptual and Conceptual stages. After the schedule and budget are set the addition of P2/WMin techniques in the project is extremely difficult if not impossible. Integrating P2/WMin in the Preconceptual and Conceptual design stages would be the single greatest opportunity to reduce the amount of waste produced and resources used throughout the lifetime of a facility. Opportunities for P2/WMin in proceeding construction stages (Execution, Operation, and Shut-down stages) are dependent on how well P2/WMin is integrated in the Preconceptual and Conceptual design stages. P2/WMin techniques that could be incorporated in the Preconceptual and Conceptual design stages include lifecycle analysis, facility siting, sustainable design, and affirmative procurement. The Environmental Stewardship Office can assist in integrating P2 in the early design stages of a project.
- Currently the Site Planning and Campus Architecture Group (PM-1) and the Environmental Stewardship Office are working together to establish a plan to build a model green facility at the Laboratory. Inclusion of green design in the Preconceptual and Conceptual stages of the TA-3 revitalization project is currently not expected to greatly affect the cost of the facility and could significantly affect the amount of waste produced and energy and water used at the facility.

#### **Initiative C-2: Perform a Process Analysis**

- Utilizing techniques such as a Green Zia Analysis to identify potential waste streams anticipated during construction, operation, and eventual closure/demolition of the facility, can identify pollution prevention opportunities.. The process analysis will also investigate available P2 design options for mitigating the waste streams and impacts identified. The process analysis will evaluate the economic and technical feasibility of P2 design opportunities, and will make recommendations for implementation considerations. The design engineers should be encouraged to utilize available P2 software, P2 design checklists or other design review techniques to identify P2 opportunities.

### **Initiative C-3: Include P2/WMin Criteria in Contract Documents**

- Request For Proposals (RFP) and contract specifications for the A/E design contractor(s) should identify the P2/WMin program goals and should include specific requirements and incentives to meeting those goals through incorporation of P2/WMin practices within the design.
- By using the results of the process analysis, a working implementation plan can be developed. This plan will include the specific actions the project will take to mitigate the identified impacts, or identify reasons actions are not being taken for specific waste streams and/or impacts. Compliance to the implementation plan should be written into the project contract documentation.

### **Initiative C-5: Construction Review**

- During the construction phase of the project many opportunities for reducing waste may present themselves that were not obvious during the design phase. Contract documents for the construction phase, including Request for Proposals (RFP) and contract specifications, will be reviewed to include P2/WMin criteria and incentives for the construction contractor. After award of the contract, regular walkdowns of the construction work areas, and inspections of waste disposal areas can be an effective tools in identifying additional opportunities.

### **Initiative C-6: Reuse of Construction Debris**

- Several excess commodities can be reused on site including used asphalt, concrete and other construction materials. Uses include fill for new roads, road base for land bridges, and land caps for ER. At the Laboratory there has been a mixed reaction to the reuse of construction debris. Previously construction debris was reused as the road base for TA-3's new East Road Landbridge at the County Landfill; however, this Landbridge was closed by the state NMED in early 1998 because of alleged improper material being included in the Landbridge Fill. The County has applied to remediate and reopen the Landbridge to all previous materials except asphalt. It is uncertain when the State may respond to the County's submission.
- Because construction waste is the largest sanitary waste stream, reuse of construction/demolition debris will have a significant effect on the waste volume. Reuse of noncontaminated asphalt is currently possible if the asphalt can be segregated from the other debris and crushed. Dirt for fill use also would reduce the volume of debris going to the landfill but may require storage for some period before use. Similarly, concrete rubble could be crushed from use as an aggregate or base course. There are several options for the reuse of construction/demolition debris. In the highway industry, pavement recycling is becoming widely accepted. Recycled asphalt pavement competes not only with the application of new bituminous pavement, but also with glasphalt that contains crushed recycled glass as a portion of its aggregate, and with asphaltic material with recycled rubber tire content.

## **B. Operations Initiatives**

### **Initiative C-7: Utilize Environmental Landscaping**

- Environmentally beneficial and economical landscaping can be implemented throughout the Laboratory. Drought resistant plants require about 1.8 acre-feet per year (AFY) of water while traditional landscaping, such as grass requires more than 6 AFY of water. Every acre that is planted with environmentally beneficial plants will save 4.2 AFY of water.

### **Initiative C-8: Recycling**

- It is anticipated that recycling of the two major categories of dumpster waste, paper and cardboard, could be increased dramatically. The Laboratory currently recycles both paper and cardboard for links on how to further recycling at your site see 1.0 Scope, Section 1.7, Relevant Documents and Links.

### **Initiative C-9: Affirmative Procurement**

- Affirmative Procurement can provide added value to the life of a facility. To support purchasing materials comprised of recycled materials in support of Executive Order 13101 the Laboratory shall purchase products made with recovered materials. BUS-4 has reviewed the items in the Just-In-Time (JIT), catalog to determine which items are in the EPA categories of Affirmative Procurement items. These items have been flagged as virgin or recycled, as appropriate. The UC Performance Measure Goal for FY99 for Affirmative Procurement is to purchase 80% of the items in these categories with recovered materials for a good, 90% for an excellent and 100% for outstanding. To achieve these goals, on March 24, 1998, non-recycled copier paper purchases were blocked in the JIT catalog. Effective October 1, 1998, non-recycled toner cartridges were blocked. For links on how to further Affirmative Procurement at your site see Section 1.7, Relevant Documents and Links.

### **Initiative C-10: Technology Development**

- During the life cycle of a facility there are many instances where technology has improved and can add a greater benefit to minimizing the amount of waste generated or energy used at a facility. The Environmental Stewardship Office can provide guidance on what P2/WMin technologies might be applicable to a specific facility.

## C. Shutdown Initiatives

### **Initiative C-11: Reuse of Construction Debris**

- Similar to reuse of construction debris during the Execution Phase debris can also be reused in the Shutdown Phase. See Initiative 6 in the Execution Phase for details.

### **Initiative C-12: Procedural Changes to Promote P2/WMin**

- Many procedural or policy changes can be implemented to improve recycle/reuse. These include a contracting provision for suppliers and subcontractors to pick up and recycle cardboard and paper packing materials, a lease instead of purchase, and an upgrade instead of replacement. Practices such as elimination of glue-bound documents and custodial pickup of recycle materials also will facilitate recycling.

### **Initiative C-13: Salvage**

- Salvage at the Laboratory can be used to order equipment as well as dispose of equipment that is still useable. To facilitate the use of salvage, try and give advanced notice. This allows salvage to find a new owner and decreases waste due to not having space to hold the material. For links on how to further the reuse of equipment at your site see Section 1.7, Relevant Documents and Links.

### **Initiative C-14: Waste Segregation**

- By far the most accessible market for source-separated demolition debris is the construction project under way that the site itself. Many of the items, such as paper and cardboard, could be recycled if they were segregated from the rest of the waste. Many of the non-recyclable items, such as plastic and Styrofoam, could be compacted and baled to minimize the landfill volume. Even demolition wood that may be contaminated with metals (e.g. fasteners) or paints may still be salable. Scrap metal, including ferrous and nonferrous metals such as aluminum (from window wall demolition), brass and copper (from old roofs, roof flashing, electrical and plumbing fixtures, and decorative uses ) and others can be separated and reused.

## 9.7 Conclusion

The P2/WMin considerations are expected to be included in all phases of engineering design and construction. This includes all phases of engineering design and construction including in the preparation of contract documents for A/E and construction services. Opportunities for implementing pollution prevention measures decrease with each successive design stage. Due to this it is critical to incorporate P2/WMin concepts as early as possible in the project's cycle. Integrating P2/WMin in the Preconceptual and Conceptual design stages would be the single greatest opportunity for the Laboratory to reduce the amount of waste produced and resources used throughout the lifetime of a facility. Opportunities for P2/WMin in

proceeding construction stages (Execution, Operation, and Shut-down stages) are dependent on how well P2/WMin was integrated in the Preconceptual and Conceptual design stages.

This is the first year that a construction related wastes program has been implemented at the Laboratory. The inclusion of construction wastes in the Environmental Stewardship Roadmap is one of the first steps to formally establishing a program within the Laboratory. The Environmental Stewardship Office is currently establishing contacts within the Project Management Division to further develop the program. The Laboratory views P2/WMin as an ongoing process. As the most significant impacts of construction waste are eliminated or put on a track for elimination, future versions of the roadmap will address the next most significant environmental impacts.

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## 10.0 WATER USE AND CONSERVATION

### 10.1 Summary

With water conservation projects now being implemented, LANL has sufficient water resources to operate present and planned facilities. Should the Laboratory significantly increase operation of present facilities or construct additional facilities, it could significantly exceed its historical water usage of 1498 AFY. While LA County, which supplies water to the Laboratory, has some unused ground water rights, a significant increase in Lab water usage, or a significant increase in County usage could exceed present water resources. Consequently, it is in the Laboratory's and the County's interest to pursue an aggressive, cost effective, water conservation and gray water reuse program. It is also in their joint interest to develop additional water resources to accommodate future growth.

### 10.2 System Description

The information presented in this roadmap represents the best information available regarding water usage at LANL; however, the uncertainty in the water quantities is significant. Until recently, accurate metering was not available for many of the larger water users, so water quantities were estimated from secondary data or from standard engineering practices. The water data for FY 1997 was chosen for much of this roadmap because that was the last year in which DOE retained water rights to the water supply, and therefore, was the most recent complete year with consistent reporting. FY 1998 water data was reported by both the County and the Laboratory, and the reporting bases were not the same.

The Laboratory used nearly 1498 acre-feet (AF) in FY 1997. Today 58% of Laboratory water flows into cooling towers. Without the cooling tower water efficiency upgrades, this may increase to as much as 69% by 2005 because of new facilities being built. About half this water is evaporated, the remainder is released into the surrounding canyons through NPDES-permitted outfalls, exacerbating existing ecological problems by causing the migration of past contaminant releases toward the Rio Grande. The cooling tower conservation project, funded by the Nuclear Weapons/Facilities & Infrastructures, will reduce the total amount of water used in cooling towers even as the new Strategic Computing Complex (SCC) comes on-line in 2002. Other conservation and gray water reuse projects described in this roadmap could further reduce water usage and ensure that future LANL initiatives are not limited by water availability.

#### 10.2.1 Water Rights

On September 8, 1998, concurrent with the lease of the water production system, the DOE leased one hundred percent of its ground and surface water rights to Los Alamos County. This includes all groundwater and water in the Los Alamos and Guaje reservoirs. The total amount of this water available to Los Alamos County and LANL from these water rights is 5541-AFY. On June 30, 1998, A *Comprehensive Agreement for the Transfer of the LAWPS by the United States Acting by and Through the DOE to the Incorporated County of Los Alamos* was signed. This commits the government to transfer ownership of 70% of the above water rights to the County and lease the remaining 30% (1662.39 Acre-feet) on a ten

year term. Beyond this transfer, DOE also “sold, granted and conveyed all of DOE’s right, title, and interest in and to San Juan-Chama Project water in the amount of 1,200 acre feet or approximately 391 million gallons per year” (DOE 1999, 2). With no existing diversion facility, San Juan-Chama water is currently inaccessible. In summary, LA County has become the Laboratory’s water supplier.

The San Juan-Chama water, if accessed by the County, could increase the water available to the Laboratory. Los Alamos County is moving forward with a project to sink a Ranney well collector system to take San Juan-Chama water from the Rio Grande. The County has funding set aside for the project for FY 2000. They plan to have a test well running in the spring of 2000, after which they will consider a full diversion project (Glasco, 1999).

### **10.2.2 Demand**

Water is consumed at Los Alamos for a variety of purposes including cooling tower, domestic, landscaping, temperature control, construction, and other miscellaneous uses. The water is eventually discharged in the form of sanitary water effluent, outfalls, evaporation or leakage losses. The water supply system and water balance for the Laboratory is shown in Figure 10-1.

In 1997, the water well system produced 3953 AF of water. Of that total, Los Alamos County used 2455 AF and the Laboratory used 1498 AF.

The water quantities presented in the water balance are based on the best data available for FY 1997, the last complete year before the water rights transfer, but have been compiled from many sources and cannot be regarded as more than an informed estimate. Water usage by Los Alamos County is well known from extensive metering. The Laboratory water usage was estimated by subtracting County usage from the known well production.

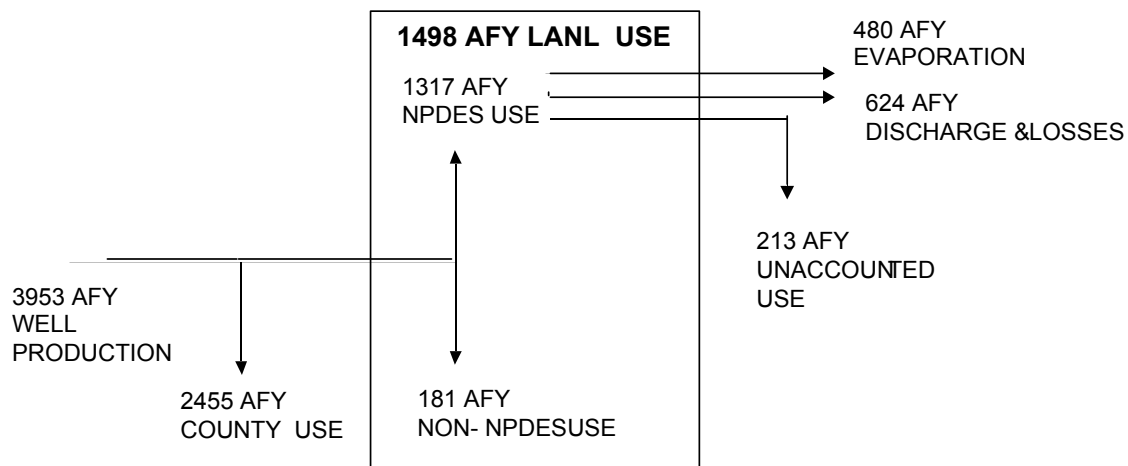


Figure 10-1. The Los Alamos water system.

Until the transfer of the water system to the County in 1998, users such as Bandelier National Monument and others were included in the Laboratory total as were leakage losses in the supply and distribution system. After the transfer, the water usage by LANL is separately metered and known with much greater accuracy.

The Laboratory's use of water is largely regulated by the Clean Water Act, which requires an NPDES permit for wastewater released to waterways. Laboratory operations are designed to produce waste waters that remain within the limits specified by the NPDES permit. Most of the Laboratory's water ends up as NPDES-regulated effluent. Non-NPDES uses include water for construction and landscaping.

There are two conclusions that can be drawn from this diagram. First, in 1997, the well production reached 71% of the total water rights of 5541 AFY. In addition, the Laboratory used 90% of its allocated 1662 AFY. The Laboratory and County together have used about the same amount of water over the last 10 - 20 years.

### 10.3 Definition of Water Usage

The FY 1997 estimated consumption of water by individual users is shown in Figure 10-2. By far the largest use of water at the Laboratory is for cooling. The various cooling towers that operate at the Laboratory consume 58% of the total. The largest cooling towers, by volume of water consumed, are the LANSCE towers at TA-53 and the TA-3 towers associated with the large computer facilities, the Central Computing Facility (CCF) and the Laboratory Data Communications Center (LDCC). The major constraints on cooling tower water efficiency are silica and arsenic concentrations in the cooling water. The concentration of silica in local groundwater is about 88 parts per million (ppm). Since silica will begin to precipitate and foul heat-exchanger surfaces at about 200 ppm, the concentration must be controlled below that level. Currently, the silica concentration is controlled by operating the

towers at 1.5 to 2.5 cycles of concentration. The effluent water from cooling towers is discharged through NPDES-permitted outfalls.

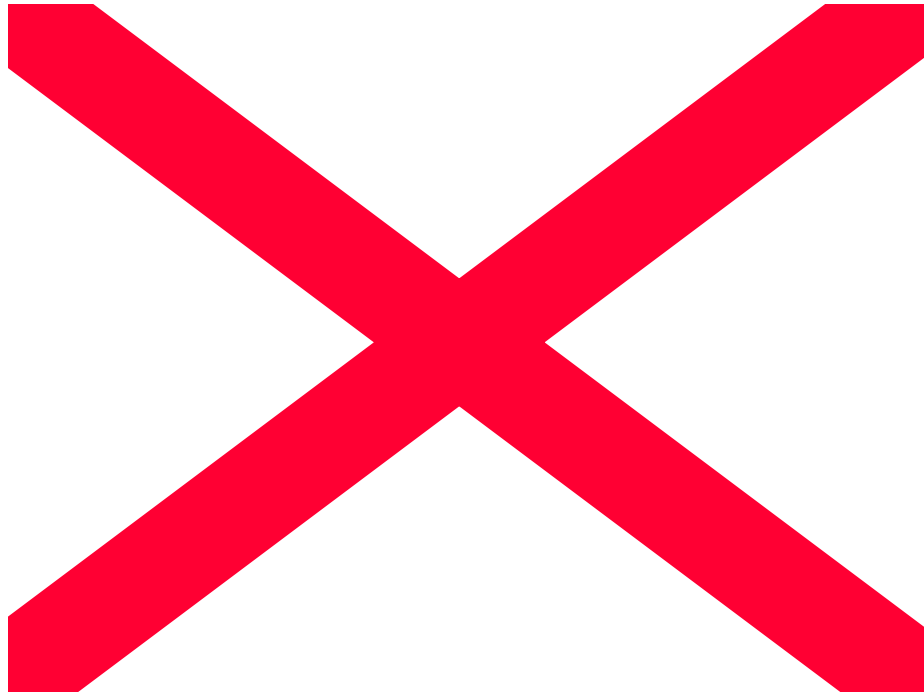


Figure 10-2. FY 1997 estimated LANL water consumption.

TA-3 and TA-53 are the major users of water for cooling towers. Usage is given for a representative recent year in Table 10-1. In addition to these major cooling towers there are more than sixty small cooling towers which, along with the Low-Energy Demonstration Accelerator (LEDA), make up the 869 AFY used by all cooling towers. The small cooling towers are widely distributed over the site and have several different operating requirements. They are not particularly good targets for implementation of water conservation actions because of their size and scattered locations

**Table 10-1. Major cooling tower water consumption for 1997.\***

<b>Cooling Tower</b>	<b>Makeup</b>	<b>Blowdown</b>	<b>Evaporation</b>
CCF/LDCC	68.00	27.30	40.70
Power Plant	62.00	27.60	34.40
SCC			
LANSCE w/o LEDA	213.10	104.93	108.16
Total	343.10	159.83	183.26

\*The Power plant, operating at less than 8 MW, uses sanitary wastewater (SWSC) in its cooling towers whereas all the other cooling towers use potable water.

Water usage by LANSCE and the power plant is highly variable and is directly correlated to power level and period of operation. As noted in the above footnote, the power plant currently operates on SWSC water at powers below 8 MW. The power plant's efficiency is poor because of its age and design. The power plant efficiency is 20 to 25%, whereas a modern gas turbine co-generation plant has efficiencies of up to 60%.

In the future the SCC, LEDA and LANSCE cooling towers will require more water. SCC initial operation will be at 30 teraops, although the 50 teraops option is included in SWEIS. At 50 teraops, the SCC will require 188.5 AFY for cooling. However, since the computers that the SCC will house are not yet designed water usage beyond 50 teraops is not known. A future maximum usage of 471.77 AFY is possible (Slamon, 1999). Initially, the SCC machine may be housed in the LDCC until the SCC facility can be built, and if so, the machine will be tied into the LDCC cooling towers. This will approximately double the required cooling water for LDCC and necessitate putting Tower 285 back in service. There are a number of unresolved issues with cooling water, facility design, and configuration for this scenario that will have to be addressed quickly if this is to remain a viable option. LEDA was originally projected to use 143 AFY of cooling water. With the scale back in LEDA operation, the water usage could be as low as 30 AFY.

The quantity of sanitary wastewater available for cooling varies from year to year. During workdays, between 350,000 and 400,000 gallons of SWSC water are generated. This amount drops to about 100,000 to 150,000 gallons per day (gpd) on weekends and during holidays. During periods of heavy prolonged rainfall, there is a significant increase in available SWSC water from inflow to the sanitary system. There are about 340 AFY of "sanitary" SWSC water available for recycle as cooling water in a typical year. In 1998, the TA-3 power plant used only 62 AF of recycled SWSC water for the cooling tower. The balance of the SWSC water was released through the TA-3 outfall. The quantity of SWSC water used by the power plant depends on the power level and duty cycle. Use of SWSC and potable water for the power plant, as a function of power, is shown in Figures 10-3 and 10-4, below.

At a generating level of 8 MW the power plant is using all available SWSC water and at power levels above 8 MW, SWSC water must be supplemented with potable water. As

demand for electrical power increases (see Section 11.0 Energy), there will be increased reliance on the power plant for peak-load following capacity. The result will likely be increased frequency of operation at or beyond 8 MW. In particular, the proposed expansion of the LANSCE operating cycle to 10 months is almost certain to require increased operation of the power plant. It is possible that in order to meet the peak demand associated with increased LANSCE operation, the power plant will be required to operate at or beyond 8 MW for longer periods, using all the available SWSC water and increased amounts of potable water during those periods. If the SCC takes all the SWSC water, the power plant will operate exclusively on potable water (Figure 10-3).

Water usage in the chart below is expressed as flow rate in gpm, to the cooling tower. Continuous flow at 210 gpm is the maximum available from the SWSC source in most years, corresponds to 340 AFY. The maximum potable water flow needed to support 20 MW operation of 315 gpm corresponds to 508 AFY.

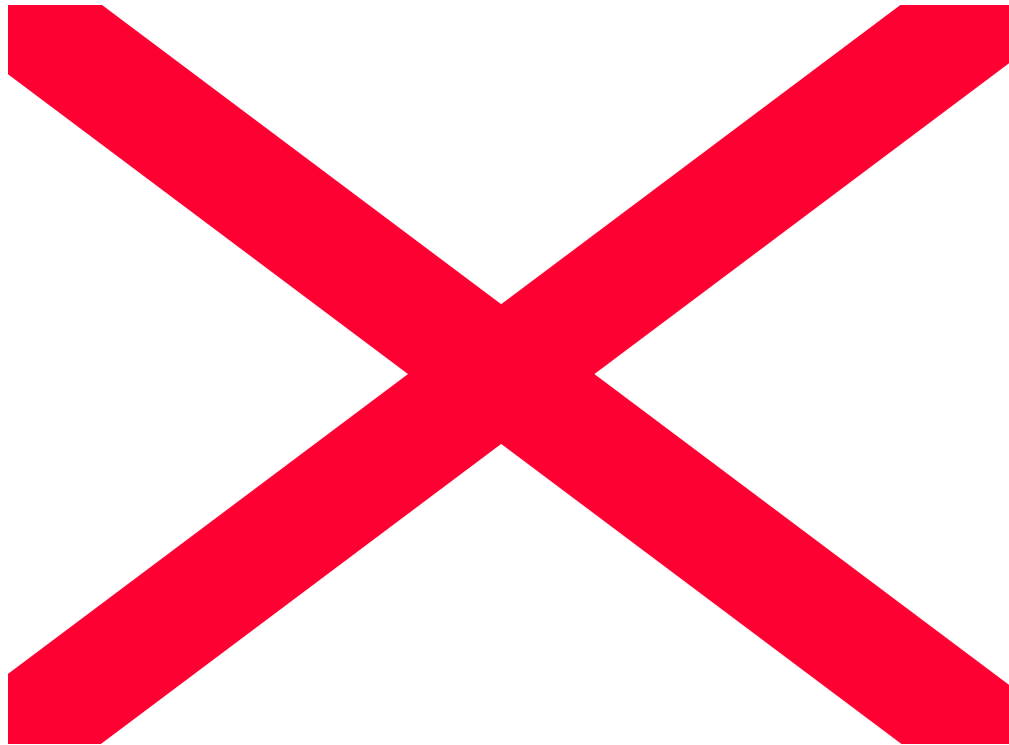


Figure 10-3. SWSC and potable water usage in power plant cooling towers.

Since the power plant only operates during periods of peak-load demand, the actual quantity of SWSC water used is variable. The 62 AF of SWSC water the power plant used in 1998, was used in the manner shown below in 10-4. This pattern of power plant generation and the attendant SWSC water usage is typical of recent experience.

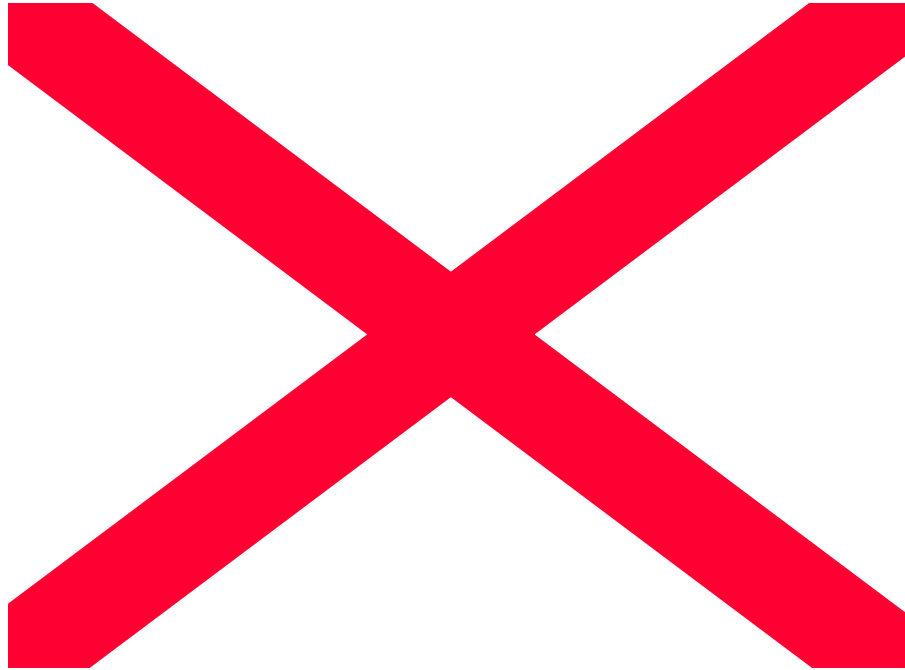


Figure 10-4. SWSC water usage by power plant in CY 1998.

## 10.4 Issues

**Issue 1:** Demand for water is growing at the Laboratory, primarily in association with increased cooling needs.

**Issue 2:** The ground water used by LANL has an unusually high concentration of silica at around 88 ppm. When the concentration of silica reaches 150 ppm, scaling in the pipes and the cooling towers can occur, and it begins to be an operational concern. At this point inhibitors must be added to the water so that the silica can remain in solution. Most cooling towers run at approximately 2 cycles of concentration or about 180 ppm of silica, at best. After two cycles of concentration, water must be discharged and makeup water added to lower the operating silica level. The necessity to prevent silica from fouling the heat transfer surfaces requires relatively high volumes of discharge and makeup water and causes the cooling towers to be the largest consumer of water at the site.

**Issue 3:** A number of the older TA-53 cooling towers have had NPDES permit exceedances due to elevated arsenic levels. These arsenic levels can be attributed to release of arsenic from treated wood used in construction of the cooling tower. Los Alamos potable water contains approximately 1 -8 parts per billion (ppb) of naturally-occurring arsenic, with an average of 3.2 ppb. The NPDES arsenic limits are under review and may be lowered in the near future. If the arsenic levels

are lowered substantially, replacement of all or part of some cooling towers may be required. Because of the potentially-high arsenic levels in the cooling tower effluent, any water conservation project will have to consider arsenic as well as silica.

**Issue 4:** Spillage from overflow of water tanks has been a common occurrence and volumes are sometimes large enough to cause significant erosion. The total volume of spilled water is not known, but it may be substantial.

**Issue 5:** A significant fraction of the total water usage was previously attributed to distribution system leakage losses. Estimates of leakage were as high as 16% of the total consumption. An inspection of the water distribution system was recently conducted, and while the leak rate is still being quantified, it is substantially lower than expected.. Leakage losses are part of the 310 AFY of unaccounted use. This use could include tank overflow and spillage, cumulative metering uncertainty in both production and usage, and well flushing, as well as leakage.

## **10.5 Initiatives**

The goal of water conservation at the Laboratory is to assure that the availability of water will never restrict operations. In order to meet that goal, the following water conservation initiatives have been identified and are briefly described below. Action plans to support each initiative, with additional information on milestones, status, and avoidance is presented in Attachment 1G.

### **Initiative W-1: Reuse all SWSC Water**

- The power plant uses SWSC water when it is generating. When it is generating at or above 8 MW it uses all available SWSC water. SWSC water that is not used by the power plant is discharged through outfall 001 into Sandia canyon. That SWSC water could be used in other cooling towers and approximately 275 AFY could be saved. The power plant will operate more frequently at higher power levels over the next few years, so its use of SWSC water will increase, but it is unlikely to use the total-available SWSC water. Unlike the power plant, use of SWSC water is best suited to facilities that have a constant load. Use of SWSC water in computer facility cooling towers would be more appropriate than use at the power plant.

### **Initiative W-2: Cooling Tower Water Efficiency Project**

- This initiative seeks the best commercial technologies for improving cooling tower water utilization. The Laboratory issued a request for proposal (RFP) to industry to pilot water conservation technologies on mobile cooling towers. The technologies will be evaluated and the selected vendor will implement their technology on the LANL cooling tower water system. The project will proceed in two phases, and although it is not currently known which technology or technologies will be adopted, a significant increase in efficiency and a savings of at least 181 AFY is expected.

### **Initiative W-3: Water System Leak Survey and Repair**

- A survey of leaks in the main water distribution system has been conducted and the preliminary findings indicate that leakage losses comprise about 140 AFY of the unaccounted use. Some repairs have been finished, and some of the larger leaks will be corrected when scheduled line replacements are made.

#### **Initiative W-4: Use of Environmentally Beneficial Plantings**

- Environmentally beneficial and economical landscaping is required, where appropriate, by Executive Order 131XX. The Laboratory currently has no plans to replace existing plantings, but all new construction will have environmentally beneficial landscaping. There is no fixed schedule for this initiative, but it will take place as new construction and renovation occurs.

#### **Initiative W-5: Outsource Construction Water**

- Free construction water is currently available at the East Jemez Road standpipe. Closing this standpipe and outsourcing the supply of construction water could result in significant water savings to the Laboratory. An alternative to closing the standpipe is to lock and meter its use. There is currently no plan for this initiative, but it could be implemented at any time.

#### **Initiative W-6: Purchase Los Alamos County Wastewater**

- Los Alamos County discharges about 1.35M gallons of sanitary wastewater per day, i.e., 1,516 AFY. One-third of this water is used for landscape watering during summer months; and the remainder is available for reuse. Opportunities for effluent recycle exist and should be investigated, although the cost of recycling this sanitary wastewater is not currently known. Because water use at the Laboratory is growing and the County is projecting growth in water consumption, it is in the best interests of both the Laboratory and the County to form a joint water conservation partnership.

#### **Initiative W-7: Import San Juan-Chama water.**

- Los Alamos County has the contract rights to 1200 AFY of San Juan-Chama Project water. This right is adjusted proportionately with actual water availability, therefore useable quantities may vary from year to year, depending on whether the year has wet or dry. This water is currently inaccessible, but the County has plans to utilize the water through a series of Ranney galleries. It is likely to be several years before the water is available at the townsite; however, the availability of this water could have a profound effect on water utilization and could result large volume extraction of water from the aquifer.

### **10.6 Effect of Water Conservation**

The projected effect of current and proposed conservation actions is shown in Table 10-2, as a function of year. Two cases are considered: first, a maximum water usage case with data based largely on the SWEIS, and second, a best-estimate water-usage case based on projections by field operation personnel. The effect of using County wastewater is not

considered in these two cases but will be discussed later. The effect of these conservation actions is presented graphically in Figure 10-5. These base cases are evaluated for two water scenarios: one with, and one without, the above conservation effort. The conservation efforts that are taken into account are the Cooling Tower Efficiency Program, the SWSC water reuse proposal, the leak repair initiative, outsourcing construction water, and utilizing environmentally beneficial plantings. The resulting savings total 640 AFY. The small cooling towers are not called out explicitly in the following table but are included in the general usage quantity because one, their use is not projected to grow, and two, none of the conservation measures are specifically appropriate for them.

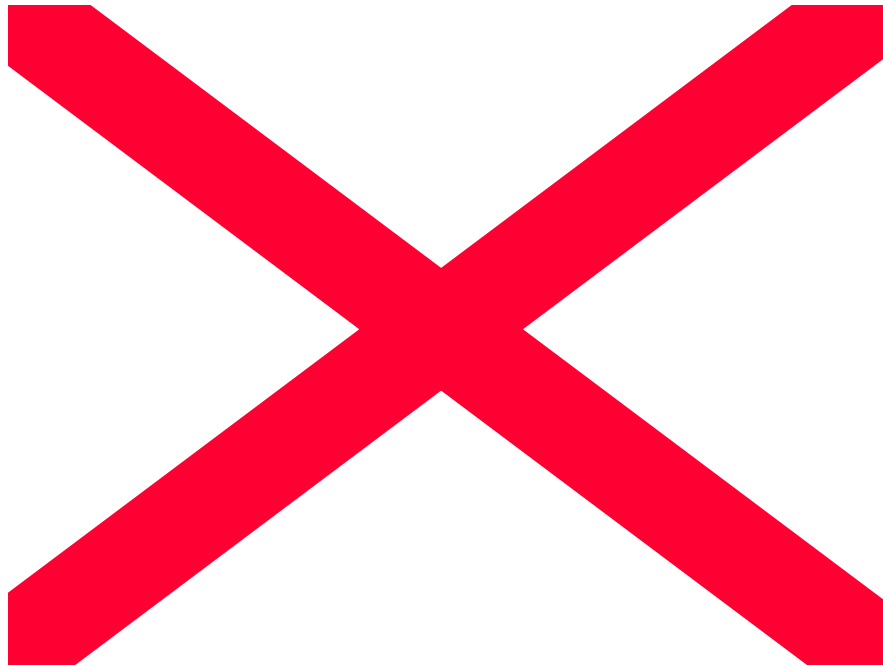


Figure 10-5. Water saved by conservation.

**Table 10-2. Water saved by conservation efforts.**

<b>Max Water Consumption</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>
LANSCE	213.00	340.40	340.40	340.40	340.40	340.40
LEDA	63.50	63.50	63.50	63.50	63.50	63.50

<b>Max Water Consumption</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>
AHF				Schedul ed		
CCF & LDCC	85.00	85.00	85.00	85.00	85.00	85.00
SCC	0	0	145.00	188.00	365.00	365.00
Power Plant	200.00	250.00	250.00	250.00	250.00	250.00
General Usage	955.00	964.60	974.20	983.90	993.80	1003.70
Max w/o Conservation	1516.50	1703.50	1858.10	1910.80	2097.70	2107.60
Conservation savings	30.70	30.70	640.00	640.00	640.00	640.00
Max with Conservation	1485.80	1672.80	1218.10	1270.80	1457.70	1467.60
<b>Best-Estimate Water Consumption</b>						
LANSCE	213.00	213.00	213.00	213.00	213.00	213.00
LEDA	25.00	29.00	17.00	17.00	17.00	17.00
AHF				Schedul ed		
CCF & LDCC	68.00	68.00	68.00	68.00	68.00	68.00
SCC	0	0	145.00	188.00	274.00	274.00
Power Plant	130.00	130.00	130.00	130.00	130.00	130.00
General Usage	955.00	964.60	974.20	983.90	993.80	1003.70
Best Estimate w/o Conservation	1391.00	1404.60	1547.20	1599.90	1695.80	1705.70
Conservation savings	30.70	30.70	640.00	640.00	640.00	640.00
Best Estimate with Conservation	1360.30	1373.90	907.20	959.90	1055.80	1065.70

The implementation of a number of conservation actions may save up to 640 AFY, allowing for significant growth.

The effect of using County wastewater is limited because there is currently no use for all of the 1000 AFY of the available wastewater. That water, in combination with the cooling tower efficiency savings, will in effect supply all the major cooling towers at the Laboratory. The effect of using County wastewater in addition to the other conservation actions is shown in Figure 10-6, below.

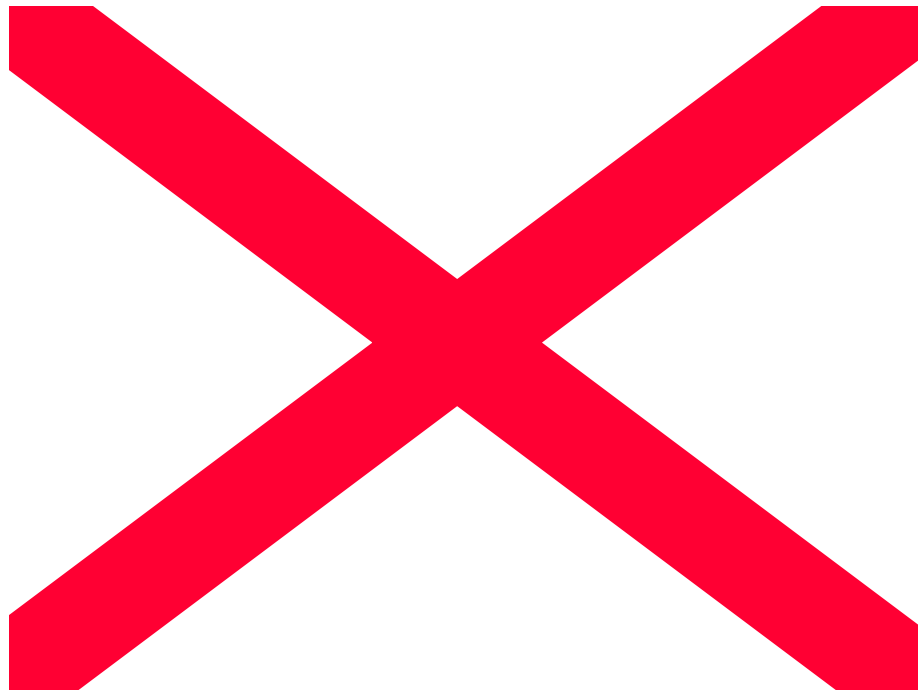


Figure 10-6. Effect of using County wastewater.

The possibility of using the San Juan-Chama water is not explicitly shown in these savings, but this water could be used instead of the County sanitary wastewater. The San Juan-Chama water has the advantage that it could be used for domestic purposes, an option which is not possible with sanitary wastewater, and its use does not deplete the aquifer. San Juan-Chama water could replace virtually all of the general usage, and reused sanitary wastewater could replace all the current cooling tower water. In this scenario only one or two hundred acre feet of ground water would need to be extracted from the aquifer each year.

LANL is continuing to develop projects that consume large quantities of energy, which will inevitably result in increased water demand. In order to meet the new demand, it is essential that LANL implement substantial water conservation and reuse measures.

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## 11.0 ENERGY USE AND CONSERVATION

### 11.1 Summary

The consumption of energy at the Laboratory has reached the point where careful planning for the future is required. Projected near term increases in electrical usage challenge the existing capacity. The future growth of the Laboratory depends on finding practical and cost efficient solutions to the energy problems. Conservation and management of energy utilization as an integrated system while planning for growth is required.

The utility system at the Laboratory is driven by demand for electrical energy. As energy requirements go up the demand for water for cooling increases and the volume of effluent discharged at outfalls also increases. Electrical supply can be increased by implementing one or more options. The critical component of the energy/water cycle, cannot easily be increased, i.e., the availability of water. (See the Section 10.9 Water.) This section, 11.0 Energy, investigates the trends in energy usage over time, examines the constraints on such usage, defines problem areas, and explores issues and options for improved performance.

### 11.2 System Description

Operation of the Laboratory requires the consumption of water, natural gas, and electricity. Air emissions and effluent discharges result from this consumption. Use of energy and water at the Laboratory are closely coupled. Water usage is discussed more completely in Section 10.0 Water. In this section, the electrical and natural gas supply systems at the Laboratory will be analyzed using CY 1997 data for analyses.

Energy usage is not regulated although the government has established guidelines for government facilities in the *Energy Policy Act of 1992* and in Executive Order 12902, *Energy Efficiency and Water Conservation at Federal Facilities*. Executive Order 12902 of March 8, 1994, mandates a 30 percent reduction in energy use for agencies by 2005 compared with FY 1985. The Laboratory has a performance measure in the University of California/DOE contract that specifically addresses this reduction. Utility loads associated with the operations of LANSCE (defined as experimental processes) are excluded from the measure. The measure is based on a reduction in energy usage from FY 1985 levels in BTUs per gross square feet of building, expressed as a percentage of FY 1985 energy usage. Total energy BTUs includes electricity, natural gas, and LPG. The performance measure calls for a reduction in FY 2000 of 25.5 percent to achieve an outstanding rating. The Laboratory already has achieved a 42 percent reduction in total energy in FY 1999.

Water consumption at the Laboratory, and to a much lesser extent natural gas usage, is driven by electrical demand. Electrical usage creates heat, which must be removed by cooling towers and 58% of the Laboratory water usage is attributable to cooling towers. As electrical demand increases, so does the demand for cooling water. Since much of the process water is eventually discharged as effluent, increased water usage tends to drive up the volume of discharged effluent. However, since some efficiency improvements are possible in water usage, discharge volume may not rise as rapidly as electrical demand.

Some natural gas is used for on-site generation of electrical energy but the preponderance of natural gas consumption in recent years has been to provide space heating. The space heating demand tends to be a function of floor space and therefore does not vary much except for seasonal variations.

The system diagram for the Laboratory consumption of utilities is shown in Figure 11-1.

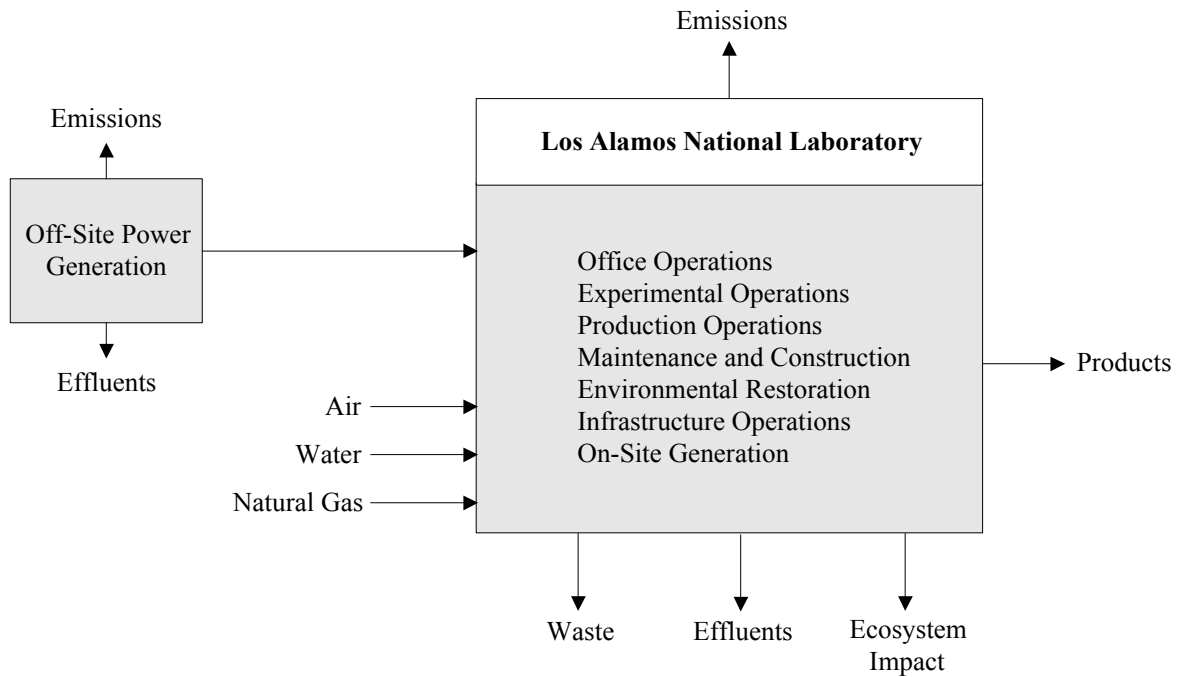


Figure 11-1. Energy process map for LANL.

### 11.2.1 Electricity

Electricity is imported into the Laboratory from off-site sources; however, because peak coincidental demand can exceed the import capacity, it is sometimes necessary to generate power at TA-3 by burning natural gas. Natural gas is also burned to produce steam and hot water for space heating and process support.

The waste streams associated with use of energy at the Laboratory are emissions in the form of industrial gasses and wastewater effluent from various cooling towers. Emissions occur on-site when the TA-3 power plant is operating and as the result of Laboratory consumption of electricity imported from off site. Emergency power generation and portable generators also produce emissions. The process map element for electrical energy use is shown below in Figure 11-2.

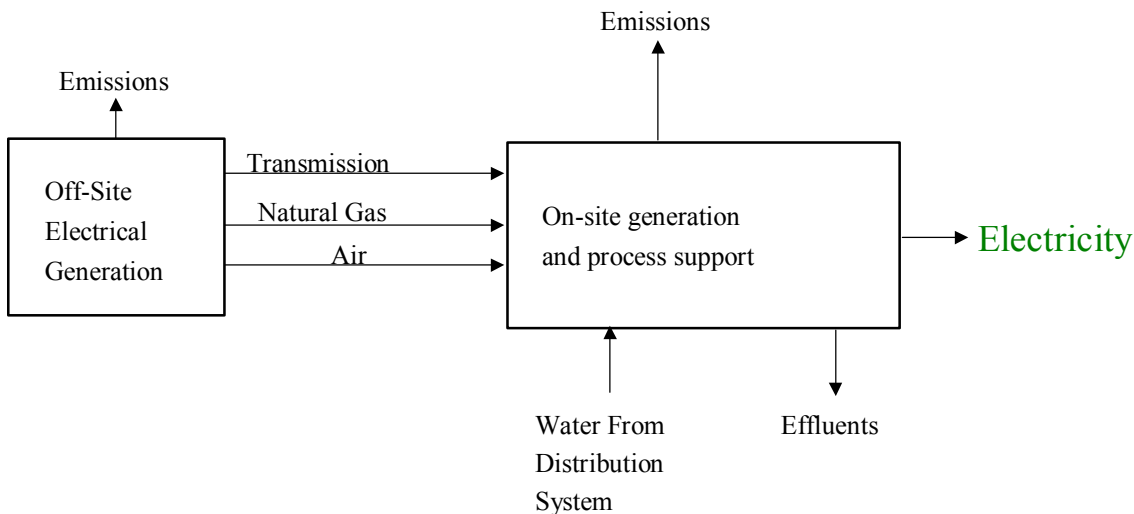


Figure 11-2. Electrical process map for the Laboratory.

#### A. Electrical Power Supply Resources

After years of stability, the demand for electrical power at the Laboratory is growing. LANL gets its electrical power from a power pool composed of the DOE and Los Alamos County. DOE and LA County have entered into a contract to purchase and own 125MW of electrical power for the power pool through the year 2015. The resources that make up the Los Alamos Power Pool (LAPP) are shown in Table 11-1 below. "Western" refers to the Western Area Power Administration (WAPA).

**Table 11-1. Existing Los Alamos Power Supply Resources.**

	Party	Capacity Rating in MW	
		Summer	Winter
TA-3 Plant (1)	DOE	20.0	20.0
Western (2)	DOE	34.9	36.1
Western (2)	County	1.1	1.6
San Juan Unit #4 (3)	County	37.0	37.0
Laramie River Station	County	<u>10.0</u>	<u>10.0</u>
<b>Subtotal</b>		<b>103.0</b>	<b>104.7</b>
Less Reserves/Losses		(12.0)	(12.0)
<b>Net Load Serving Rating</b>		<b>91.0</b>	<b>92.7</b>
El Vado	County	8.0	0.0
Abiquiu	County	<u>14.0</u>	<u>0.0</u>
<b>Capability with Maximum Hydro</b>		<b>113.0</b>	<b>92.7</b>

1. The plant rating is currently decreased to 13 MW from its nameplate rating of 20 MW due to cooling tower limitations that are scheduled to be corrected with the addition of a second cooling tower in December 1999.
2. Under the proposed marketing plan, Western's allocations are projected to decrease by 7% effective October 1, 2004.
3. The San Juan entitlement was up-rated from 35.9 MW to 37 MW effective July 1999.

The adjustment for losses and operating reserve requirements will vary depending upon what units are in operation and the level of output. The 12 MW level is representative of the level that would apply with all generation in operation. El Vado and Abiquiu resources are hydroelectric projects with their operating levels dependent upon controlled releases of irrigation and municipal water. Finally, due to high fuel costs and low operating efficiencies, the operation of the TA-3 Plant is restricted.

## **B. Transmission Import Rights**

There are both physical and contractual limits to the amount of electrical power that can be imported into the LAPP regardless of the electrical supply resources available. The LAPP has firm transmission import rights to 75 -77 MW of electricity year round and firm transmission rights to an additional 22MW in the summer when hydropower from Abiquiu and El Vado is available.

In addition, the Laboratory has an additional 7 - 9 MW of firm but curtailable power rights from WAPA. Use of WAPA power is subject to the annual usage of the Western path into Los Alamos not exceeding 442 MW-months, and the level of usage of Western's transmission path through the Public Service Company of New Mexico (PNM) system not exceeding 247 MW.

A tentative agreement between DOE and PNM regarding the Static Var Compensator (SVC) is expected to be formalized by Jan. 1, 2000. When the SVC agreement is formalized 10 MW of additional import rights are expected. Assuming the SVC agreement is formalized, LAPP's firm import rights could increase to 85 MW of transmission system use in the summer and 87 MW use in the winter.

There is no firm transmission path for the 10 MW of electricity, owned by the County, from the Laramie River Station (LRS) to LAPP. However, LRS power is sometimes traded for power that can be delivered to LAPP. For example, the 10 MW output of the LRS was recently traded to the Public Service Company of Colorado for 10 MW of their power to be delivered at either the four corners or San Juan switchyards for LAPP use. The agreement had a three month duration.

The foregoing has been a discussion of the contractual import rights into the LAPP system. In any event, the physical limit of the transmission path into the LAPP is 95 MW.

More detail regarding import rights can be found following in Section 11.5, Supporting Data.

### C. Demand

In this Section both the historical Laboratory demand for electrical energy and the projected future demand are discussed.

**Historic Power Consumption.** The current status of electrical consumption at the Laboratory is epitomized by consumption in CY 1997. The peak demand in 1997 was just 62 MW. This peak demand occurred in July, which also saw the largest usage: just over 40,000 MWh. The usage varies by month in any given year but is driven by LANSCE operation. The months in which LANSCE operates are nearly always the highest usage months. The graphs following in Figure 11-3 through Figure 11-6 show Laboratory power consumption by year; 1997 peak consumption by month; LANSCE 1997 consumption by month; and finally, Laboratory consumption by month. The trend in power consumption is also evident: after declining for a number of years, consumption is again increasing.

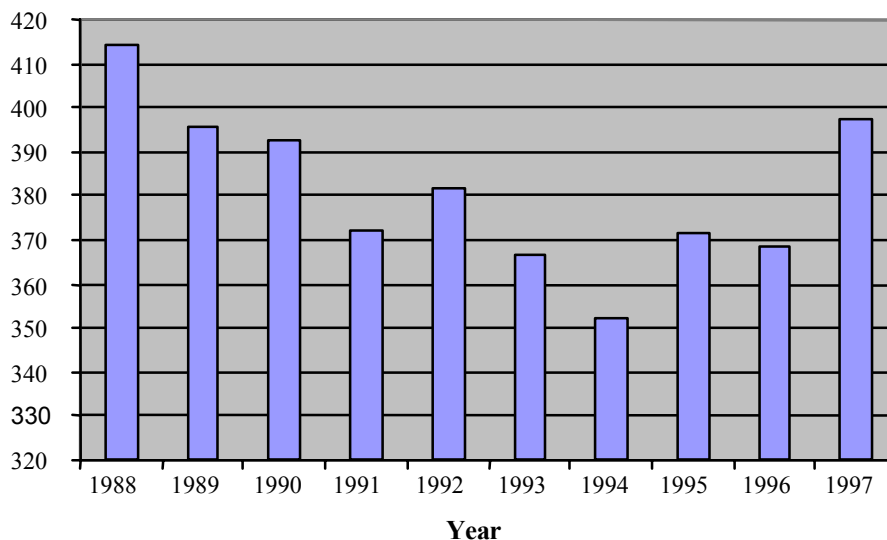


Figure 11-3. Laboratory power consumption by year through 1997 (MWh)

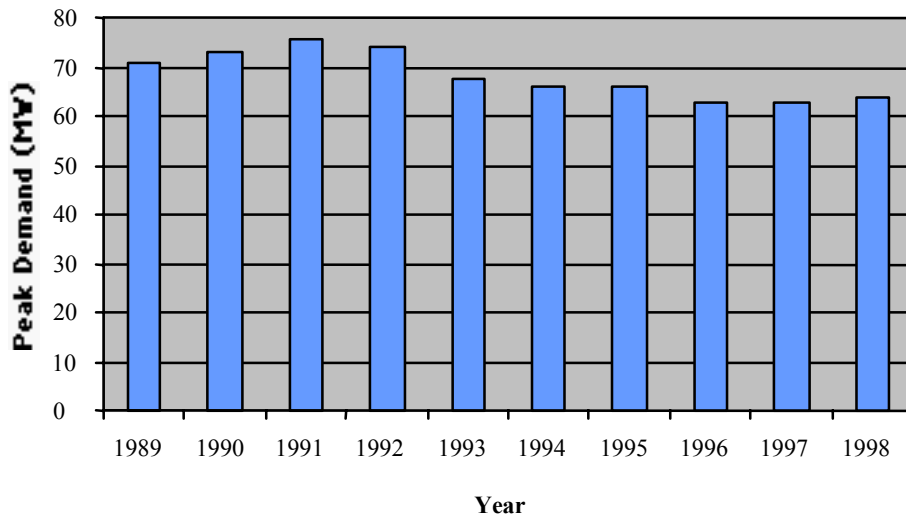


Figure 11-4. Laboratory peak demand by year through 1998 (MWh)

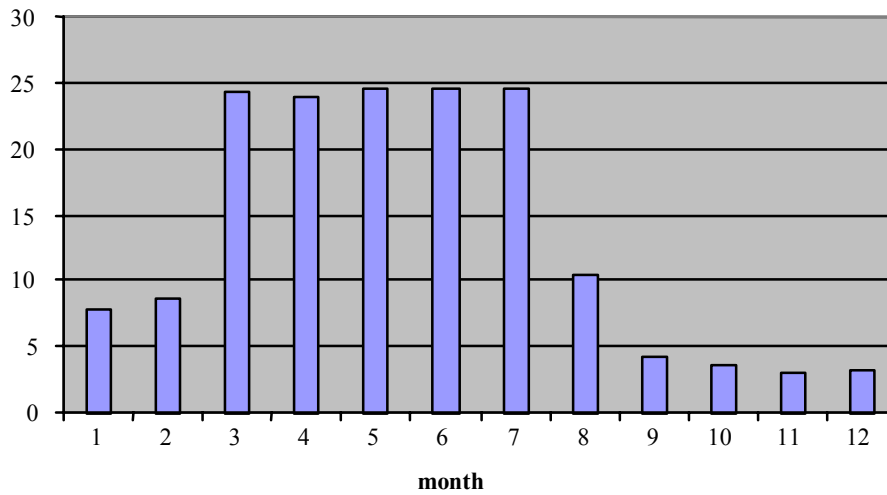


Figure 11-5. LANSCE 1997 usage by month (MWh)

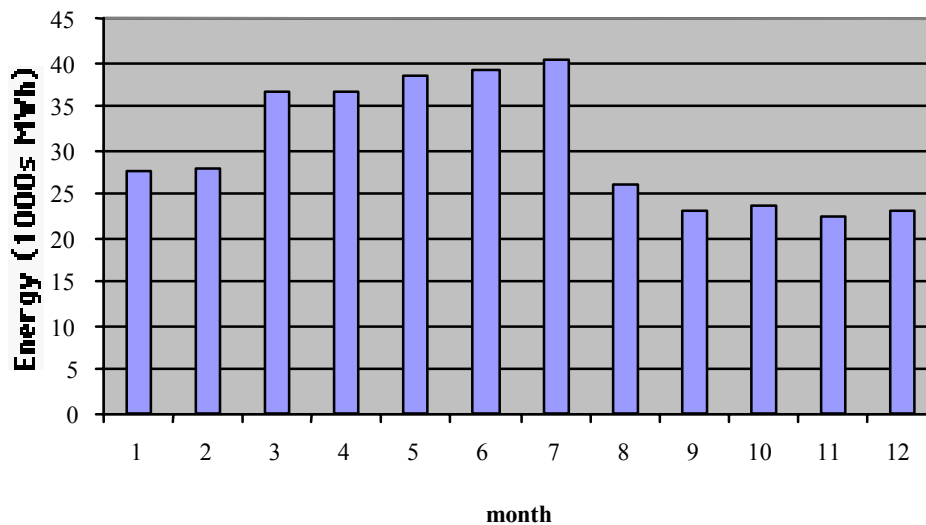


Figure 11-6. Laboratory 1997 usage by month (MWh)

The largest users of electrical energy at the Laboratory are shown in Table 11-2. The top four consumers account for up to 51 MW at coincidental peaks.

Table 11-2. Largest Electrical Energy Users at the Laboratory.

Facility	Energy Consumption (MW)	Duration
LANSCE-peak demand	25-32	24 h/d during operation
LANSCE-base load	5-7	24 h/d
Computing (CCF & LDCC)	4-5	24 h/d
TA-3	10	5d/week
TA-55	2-3	24 h/d

The above total for TA-3 **does not** include the 5 MW for LDCC/CCF. Computing at TA-3 is separate. There is a 10 MW Lab-wide peak load swing during weekends and holidays.

**Future Demand Analysis.** Electrical demand is projected to grow rapidly over the next few years due to new facilities or upgrades of old facilities. The Strategic Computing Complex (SCC), Low Energy Demonstration Accelerator (LEDA) and Dual-Axis Radiographic Hydrodynamic Test (DAHRT) are facilities that will require more power in the near future. The latest official power forecast of the LAPP reflects the following:

- LANSCE Enhancement.** Some upgrading of the Los Alamos Neutron Scattering Center Experiment (LANSCE) “RF” facility was recently completed. Future LANSCE facility power requirements of approximately 20 MW are now expected throughout the next 10-year period.

- **LEDA.** The LEDA facility, located adjacent to the LANSCE facility, will be supplied from the existing TA-53 115/13.8 kV Substation. The peak requirement of the LEDA facility is now estimated to reach 4 MW in July 1999 and then operate at that level for the three-year, 1999 to 2001 period.
- **SCC.** The Accelerated Strategic Computer Initiative (ASCI)/SCC at TA-3 is now being added, which with its full operational requirement, may reach 21 MW in 2005. The SCC equipment is being temporarily located and operated at the Laboratory Data Communication Center (LDCC) until the SCC facility is completed. Approximately 20% of the equipment is now on site and the start-up testing phase is in process. It is expected that SCC will operate at a 3 MW level in FY 2000. Initial full operation of the SCC will require 7.1 MW in 2001.
- **Other New Loads.** Ten additional projects are either in the beginning stage of operation or considered reasonably firm at this time. The available information on these projects has been reviewed to forecast the amount of load that can reasonably be expected to be coincidental with the LAPP peak. These ten projects are expected to add approximately 7.6 MW beginning in FY 2000, and could increase in steps to as much as 41.5 MW by FY 2005. Each of these loads is discussed below.
  - a. **Atlas.** Atlas is a new facility to be located at TA-35 with test equipment power requirements that are projected to be small in comparison to the background electrical requirements of the facility. Atlas recently commenced operation at its projected 1 MW load level.
  - b. **DARHT.** The DARHT Facility at TA-15 began operation at a 1 MW level in June 1999. This project is slated to reach a power requirement level of approximately 2.1 MW by October 2000. A second phase is programmed to bring power requirements for this facility to approximately 2.1 MW in 2001 and to ultimately reach 3 MW in FY2002. Project operation beyond the 2 MW level is understood to be conditioned on the expedited completion of the WTA 115/13.8 kV Substation. Further evaluation of DARHT project requirements will continue as the project design matures.
  - c. **NSCE.** The Neutron Scattering Center Experiment (NSCE) is began operation in October 1999, projected to add an additional 1 MW of load at TA-53. NSCE is expected to be a long-duration, steady base load that will operate on a coincidental basis with the LANSCE facility.
  - d. **NHMFL.** The National High-Magnetic Field Laboratory (NHMFL), operated by the University of Florida, is located at TA-35. At presently-projected operating levels, this facility has the potential for reaching 6 MW of load. The 6 MW level will occur if, and when, a 200-ton flywheel is added, which is expected not to occur for at least five years. In the past, this facility has operated at non-peak times; however, by July 1999 the 60 Tesla magnets will have been relocated to an unpopulated area. Thereafter, a production-mode operation is projected to occur

during normal working hours and add an integrated hourly 2 MW demand to the LAPP coincidental peak demands. During the ramp-up phase of its operating cycle, the NHMFL will place a 6 MW demand on the system for 30 minutes, then drop back to 1 MW while it operates in a holding phase.

- e. **CMIP.** The planned Capability Maintenance and Improvement Project (CMIP) is expected to result in approximately 2 MW of additional load at TA-55 before the end of year 2002. The facility is in the process of being transitioned from its initial application toward the disassembly of highly-reactive sources from the medical and industrial community.
- f. **DX-DO.** The Dynamic Experimentation – Division Office (DX-DO) is expected to begin initial operation at 0.5 MW in FY 2000 and reach a 1 MW level in FY 2002. This facility will serve as a headquarters facility and a new light laboratory.
- g. **Sigma/MSL.** The Sigma/Materials Science Laboratory (SIGMA/MSL) is expected to begin initial operation at 1.0 MW in FY 2000, increase to 2.0 MW in FY 2004 and reach a 3.0 MW level in FY2005. The operation includes quartz oven facilities for producing crystals to be used at the DARHT facility. A portion of the load relates to the consolidation of office and light laboratory operations that now are housed in transportables.
- h. **NISC.** The Non-Proliferation and International Security Center (NISC) is expected to commence operation at 0.5 MW in FY 2002. This is a new building that will serve office and light-laboratory functions. It will operate in conjunction with the ASCI facility.
- i. **Research Park.** The Research Park is expected to begin initial operation at 0.5 MW in FY 2003, and progress to 1 MW in FY2005, 1.5 MW in FY 2007, and 2.0 MW in FY 2009. The environmental assessment described the Research Park as having a potential for 1,000 people with a 10 MW load. The Research Park is to be considered a County load served by an additional feeder from the TA-3 Substation.
- j. **AHF.** The Advanced Hydrotest Facility (AHF) is expected to begin initial operation at 5 MW in FY 2003, reach 10 MW in FY 2004, and reach a 21.5 MW level in FY2005. The foregoing numbers are considered to be mid-range projections. Indications are that the program has the potential for growth beyond these initial mid-range forecast demand levels.

In light of the above-described load additions that have firmed up during the past year, an updated “official” LAPP forecast was distributed in March 1999. Some subsequent refinements were made by LANL to incorporate updated information. These refinements included a modification of the year 2000 monthly-projected schedule of the LANSCE load and a reduction in the DARHT demand by one-half, to more correctly reflect its integrated hourly demand contribution. In addition, some minor non-coincidental demand reductions

also resulted from the monthly demand distribution modeling process. The March 1999 document, modified by the above noted changes, resulted in the demand requirement forecasts set forth in Figures 11-7 and 11-8 below.

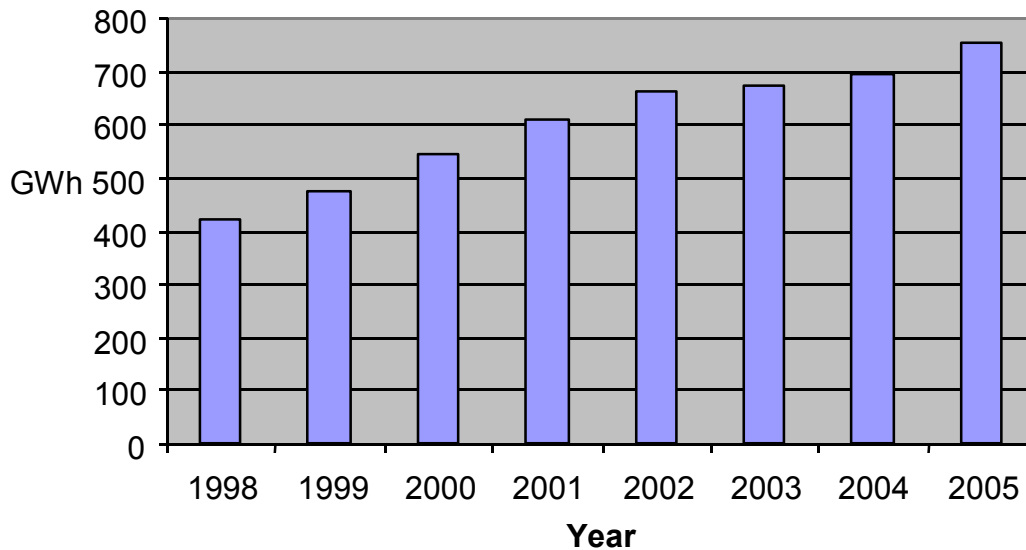


Figure 11-7. Projected LANL annual electrical consumption.

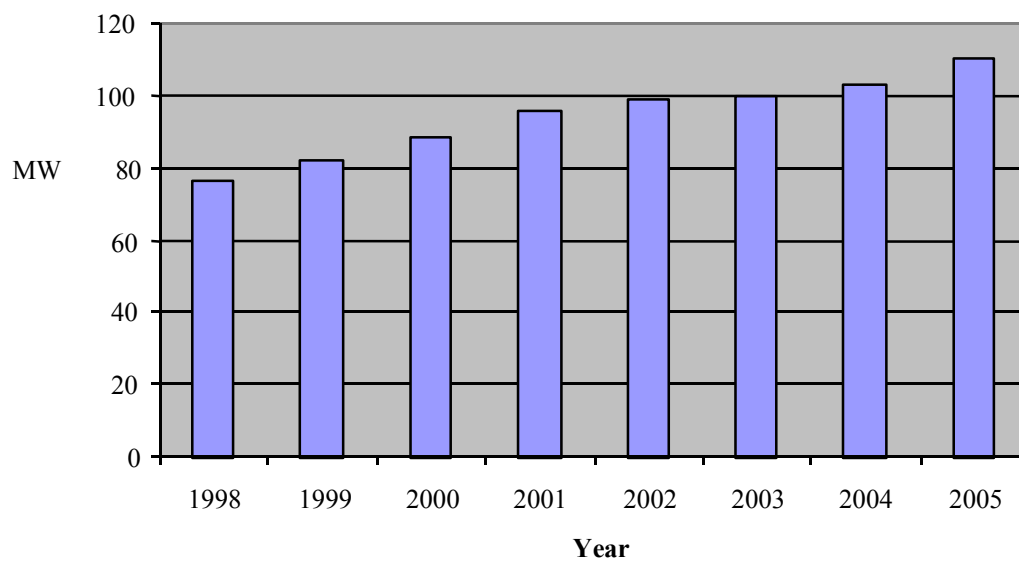


Figure 11-8. LANL projected annual peak demand.

The components of peak electrical coincidental demand for the major users are shown below in Figure 11-9.

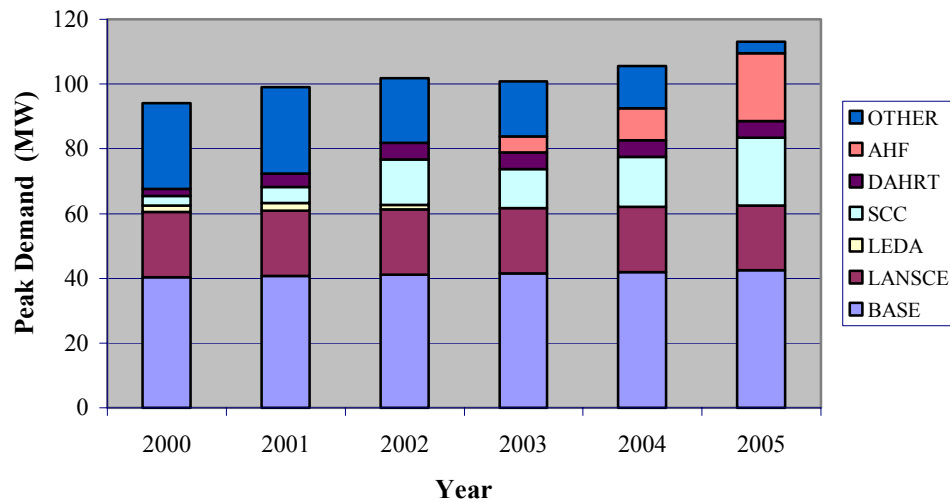


Figure 11-9. Major user peak electrical coincidental demand.

This chart graphically demonstrates that by 2001 the peak demand is projected to exceed the contractual firm load serving capacity of the existing transmission lines, as well as the maximum physical capacity of the lines. Growth in Los Alamos County usage, to about 15 MW included in the "other" total, will be driven primarily by the operation of the Research Park beginning in 2003. Other growth in County electrical demand is expected to be slow.

It is possible that peak demand could increase to 120 MW or more over the next few years. This increase in electrical demand creates two problems: first, the transmission capacity of existing lines is currently physically limited to a maximum of 94 MW; and second, additional water will be required to provide cooling. The existing electrical transmission capacity is inadequate to meet the projected peak demand, and in fact is inadequate for current peak demand under some conditions. The solutions are to add transmission capacity, to increase on-site generation by adding a modern high efficiency power plant or a combination of the two.

#### **D. Cost of Power**

The power contract with San Juan, Laramie River, El Vado and Abiquiu is financed by a bond issue in the amount of \$110M. The bonds were issued by the County after the County and DOE entered into a 30 year power pooling agreement. The DOE is also a signatory to the bond issue. This bond issue pays for ownership of the generating equipment associated with the electrical resources from these facilities. Servicing the debt from this bond issue represents a fixed cost that is paid by the LAPP regardless of the actual level of usage of electricity from these resources. The cost of power from facilities owned by the pool is

variable and is predicated on maintenance, fuel, operating costs, etc., associated with actually producing the power.

Overlaid on these fixed costs are the costs of power imported from the various resources available to LAPP. Electricity is scheduled into the pool on an hourly basis. Hydropower, if available, is scheduled first. Then San Juan and Western power are scheduled in order to make up the required quantity up to the 75 - 77 MW firm transmission limit. Requirements beyond 75 - 77 MW can be made up from non-firm resources or by purchasing power on the open market. The price paid for power bought on the open market varies by day, hour and type of power and is based on the Dow Jones Palo Verde Electricity Index for power traded at West Wing and Palo Verde Arizona. Power that is scheduled, but not used, is sold back on an hourly basis. The price paid to the County for that power varies widely depending on the grid demand that day and whether the power sold is peak, non-peak, and either firm or non-firm. The Laboratory can either make or lose money on the sale of unused power. Generally, power sold back to the grid is sold at a marginal loss. For example, in June of 1999 the price paid to the pool for the sale of unused scheduled power ranged from \$11/MWh to \$65/MWh for on-peak power and from \$8.35/MWh to \$29.50/MWh for off-peak power. The average of all power sold in June 1999 was \$21/MWh. The pool paid \$55/MWh for that power. The pool sold 481 MWh total.

The cost of power to the Laboratory depends on the source of the power. The current cost of imported power to the LAPP is \$55/MWh wholesale. This is the average aggregate cost of all electricity delivered to the LAPP from its various resources. The Laboratory charges large users such as LANSCE \$62.50/MWh and other users \$70/MWh. The Laboratory pays the pool monthly for electrical use. The pool combines the Laboratory payments with County usage and adjusts the charges to ensure cost recovery. The Laboratory is then either billed for the difference or refunded the overpayment. The cost of imported power is projected to rise to \$61/MWh wholesale by the year 2000. The future cost of imported power including the proposed new Colorado/New Mexico Intertie Project (CNMIP) transmission capability is expected to rise to \$65/MWh.

If demand exceeds the load serving capability available to the LAPP over transmission lines, power can be generated at the TA-3 power plant. The current cost of on-site generation is \$100-180/MWh depending on a number of factors including fuel cost and availability, lead time to begin generation, overtime costs, and generator output. The power plant was designed to operate at 20 MW and is carried as an LAPP resource at this power level. However, it cannot currently operate beyond 13 MW and is seldom used to generate more than 5 MW. If it were operating at capacity, the costs would be reduced. The cost of operation of the TA-3 power plant is paid out of the Laboratory operating budget. Power plant operation for recent years is shown in Figure 11-10.

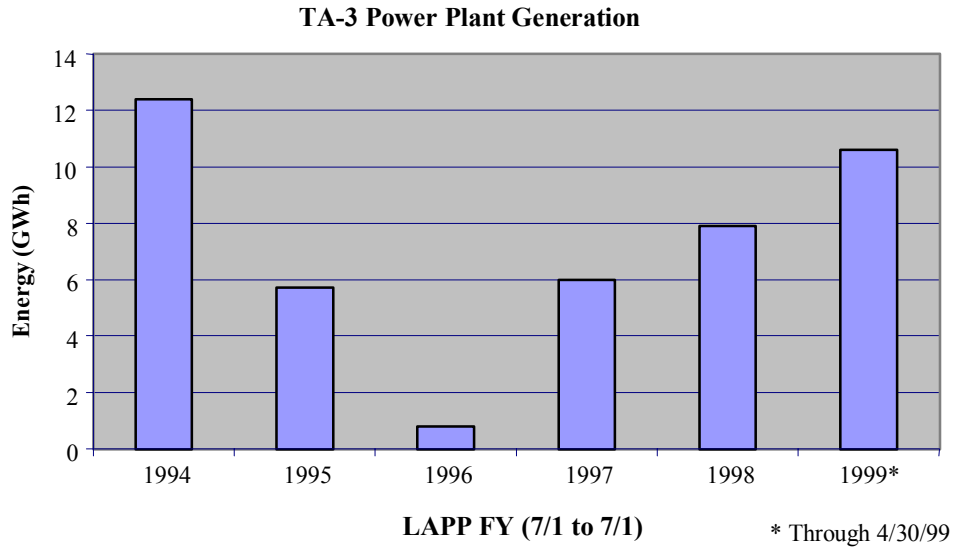


Figure 11-10. TA-3 power plant generation.

The cost behavior for electrical power consumption can vary widely with time of year and time of day. The power consumption year can be conveniently divided into four periods depending on LANSCE operation and whether the power is peak or non-peak. These numbers are currently being developed and this section will be updated when the data is available.

### 11.2.2 Natural Gas

Natural gas is purchased from the Defense Fuel Supply Center and delivered via the DOE-owned Kutz-Los Alamos transmission pipeline. This natural gas is used in one of two ways: for on-site generation of electricity at the TA-3 power plant; or for space heating and process support. The process map element for natural gas consumption at the Laboratory is shown in Figure 11-11. The processes result in emissions in the form of industrial gasses and effluents in the form of cooling tower discharge.

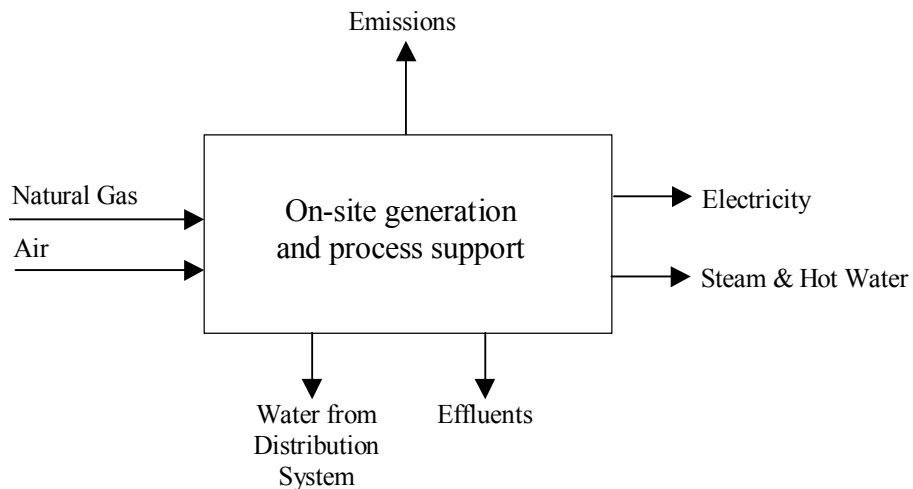


Figure 11-11. Natural gas upper-level process map for LANL.

## Natural Gas Demand

During a recent 12-month period, gas usage totaled 1.36 million dikatherms. Natural gas consumption is primarily space-heating demand driven with peak demand normally occurring in January or February.

About 50% of the natural gas purchases are delivered to two large central steam plants at TA-3 and TA-21. While the primary steam loads at the TA-3 and TA-21 plants are associated with building space heating, there is significant summer steam production. Steam plant gas production during the minimum-usage summer months is about 40 % of the winter peak. While there are some non-weather related loads such as water heating and process supply, it is likely that a significant portion of the summer usage can be attributed to aging of the distribution systems. The central steam plant that had operated at TA-16 has been replaced by a distributed heating system that has substantially-reduced gas consumption associated with heating loads.

The TA-3 plant is included in the Los Alamos Power Pool as an electric power generating resource. The TA-3 plant was designed to operate in both conventional power generation mode or in co-generation mode with turbine extraction to meet steam demand. Currently, the plant operates primarily co-generation mode supplying steam to the TA-3 steam distribution system and generating electricity for on-site use. The ratio of natural gas burned for steam and for power generation is highly variable. For several years prior to 1998, the plant operated predominantly in the steam supply mode, but during 1998 electrical demand increased significantly so that the quantity of natural gas consumed for power generation has also increased.

**Table 11-3. Distribution of natural gas consumption in 1998.**

User	Consumption Percentage
TA-3 space heating	45%
TA-3 power generation	5%
TA-16 space heating	10%
TA-21 space heating	5%
Other space heating	35%

The waste streams associated with Laboratory use of natural gas are: discharge of waste water from cooling towers necessitated by natural gas burning; and generation of industrial gases. To the extent that use of natural gas can be avoided, the waste streams will be reduced.

### 11.3 Issues

**Issue 1:** Electrical demand at the Laboratory is growing, and over the next five years, demand associated with known projects is likely to increase by as much as 45 MW.

**Issue 2:** There is limited capability to import power from off-site because of limitations on transmission line capacity. The Laboratory operates near that limit today and frequently exceeds it, requiring the use of on-site generation to meet load demands. Without additional transmission line capacity, or additional on-site capacity, the Laboratory's ability to grow will be severely limited.

**Issue 3:** On-site generation has been increasing over the last 3 years and will continue to increase. The TA-3 power plant is aging and needs to be upgraded or replaced if enhanced on-site generation is planned.

**Issue 4:** Significant increases in on-site generation will require an upgrade in natural gas delivery such as increasing the delivery pressure of the natural gas pipeline.

**Issue 5:** Significant increases in on-site generation will require an upgrade in the natural gas delivery system, such as increasing the operating pressure of the natural gas pipeline.

**Issue 6:** The steam supply system for hot water and space heating is aging and leakage may be contributing significantly to losses.

### 11.4 Initiatives

There are a limited number of possibilities for increasing Laboratory access to electrical power and meeting the projected future power demand. The following initiatives are the most promising.

#### **Initiative E-1: Install a third transmission line.**

- The planned third transmission line development is recommended for reliability reasons whether or not local on-site generation options are implemented. From the standpoint of least-cost operations, the LAPP should have the flexibility to shut down local generation when lower cost energy can be purchased from remote sources. The third source into the LAPP could increase the firm load serving capability by as much as 50 MW. Without the third line, DOE remains exposed to complete loss of service when one of the two existing lines is out of service for extended periods of time.

#### **Initiative E-2: Refurbish the TA-3 Power Plant.**

- A range of major upgrades, including overhaul of the Unit 2 and Unit 3 turbines and generators, and refurbishment of the existing cooling tower, were previously identified as necessary if the TA-3 Plant is to be relied upon for regular production of electrical energy. Two projects, one for the addition of the second cooling tower and

the other for a replacement-burner management-control system, are in process for completion by year end 1999. A number of further projects are possible and desirable if the power plant is to be restored to 20 MW operation. Indications are that the existing TA-3 generation revitalization can be largely accomplished with General Plant Project (GPP) and/or operating funds, and thereby avoid the budget delays normally encountered with line item capital projects.

**Initiative E-3: Install a 10 MW combustion turbine at TA-3.**

- As a variation of TA-3 Plant revitalization, there is the option of installing a 10 MW or larger combustion turbine and a heat recovery boiler. The unit would probably be located adjacent to the existing TA-3 generating plant. This should allow the use of the available fourth generator terminal position in the existing 13.8 kV switch gear. Also, steam produced in the heat recovery boiler can be piped into the existing steam header and run through one of the existing 5 MW extraction turbines then exhausted to the steam heating system.

**Initiative E-4: Install a large combustion turbine.**

- The large gas turbine/generator approach has been suggested by at least four parties that are interested in development of energy generation at Los Alamos. Such a project does not appear to be well matched to the Los Alamos needs. From a load-resource point of view, it would result in approximately 40 MW of generation in a combined cycle or co-generation mode with 10 MW of existing TA-3 generation. If one were to assume base load operation of 40 MW at 85% load factor, this would produce approximately 300 GWh of energy annually. This is about six times the supplemental requirements in the year 2002 and year 2003 time frame, and more than double the projected year 2009 supplemental requirements. Given the desire not to be saddled with fixed costs (potentially in the range of \$4 million to \$7 million per year) for excess resources, such a plant at Los Alamos would have to be viewed as a merchant plant.

**Initiative E-5: Conservation.**

- There is an operational incentive to conserve electricity. As much as 3-5 MW of usage could be avoided through implementing simple conservation measures such as energy star computing. Further savings will be realized, without additional cost, through projects already planned, such as chiller upgrades. The chiller upgrade will save up to 6 MW. The proposed LANSCE 2.01 MHz upgrade will result in a savings of about 1 MW. These measures may be a very effective short term solution to the peak-demand problem, since a reduction in demand through conservation will mean that near-term growth will not challenge the combined firm load serving capability of off site import to operate the TA-3 power plant. The power plant produces particularly expensive power and its use has been increasing in response to the growth of peak coincidental demand. It may be possible to conserve as much as 10 MW.

**Initiative E-6: Increase delivery pressure for the natural gas pipeline.**

- The existing gas delivery system into Los Alamos is rated at approximately 25 million cubic feet per day, with peak winter requirements from heating usage alone reaching, and on occasions exceeding, the full capacity of the pipeline. Thus, under peak winter heating requirements, there is no available gas system delivery capability to support operation of additional TA-3 or combustion turbine generation. Public Service Company of New Mexico Gas Services (PNMGS) is proceeding with gas system upgrades that would adequately increase the capability to accommodate a combustion turbine at Los Alamos. These upgrades are expected to be complete by the summer of year 2000.

**Initiative E-7: Replace central steam plants with distributed heating at TA-3.**

- The central steam plant at TA-3 is old and is probably leaking. Steam generation for heating at TA-3 accounts for about 40% of LANL natural gas usage. Average steam costs are about \$10 per pound, based on total operating costs. It is likely that building heating needs could be met at substantially lower costs through decentralized heating systems. It is also likely, though unproven, that modern decentralized systems with their higher efficiencies, smaller distribution systems, and lower parasitic losses would result in smaller waste streams. The planned reconfiguration and upgrade of TA-3 will provide an excellent opportunity to include decentralized space heating.

**11.5 Supporting Electrical Data for the Laboratory.****Table 11-3. Los Alamos Power Pool Transmission Import Rights.**

<b>Firm</b>	<b>Summer (MW)</b>	<b>Winter (MW)</b>
San Juan (PNM)	37.0	37.0
Western Basic Hydro (PNM)*	36.0	38.0
Control Area Service Agreement (PNM) Maximum Firm	<u>2.0</u>	<u>2.0</u>
<b>Transmission Rights (PNM)</b>	<b>75.0</b>	<b>77.0</b>
<u>Additional Firm Depending on Hydro</u>		
El Vado (NORA/Jemez/Plains/PNM)	8.0	
Abiquiu (Jemez/Plains/PNM)	<u>14.0</u>	
	<b>22.0</b>	
<u>Firm Curtailable</u>		
Western Conditional (PNM) **	<b>9.0</b>	<b>7.0</b>
<u>Pending Available Transmission Capability</u>		
SVC Tentative Agreement (PNM)		
CNMIP (Western/PSCO/Tri-State/PNM)/	10.0	10.0
NL-NH Reconfiguration Project (PNM)	up to 50	up to 50

\* Under the proposed marketing plan, effective October 1, 2004, the Western allocations are projected to decrease by 7%, or approximately 2.5 MW.

\*\*Subject to the annual usage of the Western path into Los Alamos not exceeding 442 MW-months, and the usage level of the Western transmission path through the PNM system not exceeding 247 MW.

The cost of power at the Laboratory depends on the source. The current cost of imported power is 5.5 cents per KWh wholesale to the power pool. The Laboratory charges heavy users 6.25 cents per KWh and other users 7.0 cents per KWh. The cost of imported power is projected to rise to 6.1 cents per KWh wholesale by the year 2000. The future cost of imported power including the proposed new transmission capability is estimated to be 6.0 to 6.5 cents per KWh. The current cost of on-site generation is 10 to 18 cents per KWh depending on a number of factors, including fuel costs, lead time to begin generation, overtime costs, and generator output. The power plant was designed to operate at 20 MW but is seldom used to generate more than 5 MW. If the power plant were operating at capacity, the costs would be reduced.

The Laboratory electrical energy usage data was obtained from Group FWO-UI.

## **12.0 EMPLOYEE POLLUTION PREVENTION AWARENESS**

### **12.1 Summary**

Environmental stewardship is the responsibility of every person working at the Laboratory. The purpose of the awareness program is the effective and efficient communication of information to Laboratory and contractor staff that will enable them to be sufficiently informed and motivated to implement the Laboratory's Stewardship Program. The awareness element of the Stewardship Program continues to be developed. This roadmap describes the activities and initiatives of this developing program.

### **12.2 System Description**

The Laboratory's pollution prevention activities operate under environmental policy and guidance from DOE, the University of California, the EPA and the State of New Mexico. These agencies set goals and performance requirements as well as interpret legal requirements for the Laboratory. In order to reduce pollution, protect the environment, promote environmental consciousness and comply with the policies and guidance of the regulatory bodies, it is necessary to facilitate the rapid and accurate transfer of information among all employees. This is the responsibility of the Laboratory pollution prevention awareness program

Awareness planning occurs at multiple levels and includes diverse target audiences. It focuses on the integration of environmental awareness into work planning and execution and on environmental problem solving. Awareness planning seeks to establish a number of clear communication channels. These communication channels facilitate the timely and complete exchange of information with and among the various segments of the work force.

Awareness activities are designed to promote an environmentally conscious work ethic through targeted communication programs, employee environmental training, a series of awards for recognition of environmental excellence, and assistance to waste generators. These activities will help to fully and visibly integrate pollution prevention and waste minimization into conduct of work at the Laboratory. These activities are embodied in the initiatives described in the following section.

### **12.3 Initiatives**

Currently the focus of the ESO pollution prevention communication program is the individual employee. In the future this focus will be enlarged to include several internal audience groups as well as the public and sponsors. The communications vehicles for reaching these target audiences are listed below.

#### **Initiative AB-1: Develop Lab-wide Communication Program Plan**

- Create a formality of communication that will include a logo for ESO for name recognition and ease of identification of Lab environmental ethics. In addition, this logo

and format will be utilized by all ESO personnel on all ESO letterheads, web pages, reports, signature lines of e-mails, business cards, and any appropriate items to further the ESO mission. The object is to have all Lab personnel recognize the ESO posters/communications. All communications will be unified by a common symbol.

**Initiative AB-2: Implement Pollution Prevention in Formal Training.**

- All Laboratory personnel must undergo general training as well as specific training when warranted. These training requirements offer unique opportunities for the ESO to explain its services and provide information to all employees. Because the majority of the current training modules do not adequately address pollution prevention concepts, the existing training material will be reviewed and revised as necessary to provide information to employees that will enable them to incorporate pollution prevention techniques. Three modules have been identified as representing the most effective cross-section of Laboratory employees. These include the General Employee Training (GET) which is provided to all employees; the Waste Generator Overview training which focuses on specific waste generators; and a training course that will be developed to address the needs of Waste Management Coordinators (WMC).

**Initiative AB-3: Expand Awards Program.**

- P2 Awards are presented to Lab employees as part of the annual Earth Day activities. The Pollution Prevention Awards Program is a feature of the Environmental Stewardship Office where cash awards are allocated annually to improve the awareness of Pollution Prevention at Los Alamos. The LANL web page that contains additional information on this program may be accessed at the URL: <http://emeso/lanl.gov/projects/p2awards>.

**Initiative AB-4: GSAF Program**

- Generator Set-Aside Fee Program (GSAF) is managed by ESO to encourage the Laboratory personnel to purchase more efficient equipment or other source reduction improvements (elimination of waste at the source) which will minimize waste generation and improve Laboratory operations. FY2000 will have \$800,000 in new (unburdened) funds for waste minimization investments.

**Initiative AB-5: Enhance Web Pages**

- The ESO web pages convey information to Lab employees in the concerning P2, waste minimization, and many other areas that ESO supports. The main page, or home page for ESO will be enhance to display and index the ESO capabilities to inform Lab employees of P2/E2 data and success stories. This web site also needs to be maintained on a monthly basis to provide the latest information concerning the Lab's Environmental Stewardship goals. Complete information about how to contact ESO personnel will be provided along with direct email links.

**Initiative AB-6: Direct Communications to all Employees**

- The DOE and UC performance measures require that the Los Alamos National Laboratory effectively reduce our waste streams. The Laboratory has effectively reduced some of the most significant waste streams. However, the Laboratory also needs to tackle the smaller waste streams (electricity and sanitary waste) because it will help the Laboratory achieve the DOE and UC Contract waste minimization and recycling goals. The Environmental Stewardship Office (ESO) took the initiative to help the Laboratory achieve our contract goals by putting together a brief presentation communicating how Lab staff can help the Laboratory conserve electricity and reduce sanitary waste. By October 2000, our goal is to reach all Laboratory employees at the group level. The topics the presentation will cover are: 1. Why the Laboratory must conserve electricity and reduce waste; 2. How staff can conserve electricity and reduce waste; 3. The impact Lab wide conservation and reduction activities have on the Laboratory; and 4. What resources and programs are available at the Laboratory to assist employees to do more.
- The daily Laboratory Newsbulletin media appears on the Lab's home web page and reaches a large audience, both within and outside of the Lab. This media contains 3 or 4 short news items per day. ESO will submit articles that will list the ESO web page URL on a monthly basis to be included in this media. The Newsbulletin Bulletin Board will be utilized for all ESO information of general interest. This will identify ESO both in and out of the Lab with environmental ethics and success stories.
- This plan should include two or more invited guest speakers each year. Speakers could also be invited to workshops held by ESO or E Division. In the Los Alamos National Laboratory culture, the Environmental Stewardships goal is to educate, assist and promote environmental excellence. Of the approximately 7,000 University of California Employees, 3,400 are Technical Staff Members. A large majority of these people are scientists involved in various research and technical development areas. To that end, the Stewardship Office would like to offer seminars, such as the Director's Colloquium, with renowned speakers in the areas of environmental ethics and pollution prevention to attract the attention and attendance of scientists at the Laboratory.

**Initiative AB-7: Implement Public Communication**

- ESO will release news items within the Laboratory's news release policy that will provide P2/E2 success stories to public news media in Northern New Mexico. One release for the first calendar quarter followed by two releases for the next three calendar quarters and the subject will be determined by the ESO team.

**Initiative AB-8: Stewardship Brochures**

- Individuals and groups in/out of the Lab need to learn about the resources that ESO has available for Stewardship/P2. Two marketing brochures will be created to provide this information. One of the brochures will contain general information to display the ESO mission, key ongoing ESO programs & projects, and ESO general contact information.

The second brochure will be in the form of a folder that can be customized for specific audiences/individuals with a core of basic information about ESO and the addition of appropriate fact sheets related to individual programs & projects.

**Initiative AB-9: Assistance**

- The ESO provides assistance to waste generators to identify pollution prevention/waste minimization opportunities, to solve pollution prevention/waste minimization problems, to obtain funding, and to solve infrastructure problems. By integrating these activities into a more team structure, the level of assistance can be improved. By informing waste generators of ESO expertise, the number of calls for assistance should dramatically increase.

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### **13.0 SUMMARY**

The Environmental Stewardship Program supports the Laboratory's goal of zero environmental incidents and zero RCRA violations through operational improvements that eliminate the source of incidents and violations. These sources are waste, pollution, natural resources wastage, and natural resources impact. The Stewardship Program has taken a systems approach to eliminating these sources that is summarized in this Stewardship Roadmap document. The roadmap identifies recent waste minimization, pollution prevention, and conservation successes, as well as improvement initiatives now being implemented or being proposed for implementation. It also identifies performance measures that will track the impact of the initiatives. Implementation of the Stewardship Program described here should result in Laboratory operations that approach zero waste generation and zero environmental impact.

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## **14.0 ACKNOWLEDGMENTS**

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## **APPENDIX 1: INITIATIVES BY WASTE TYPE**

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